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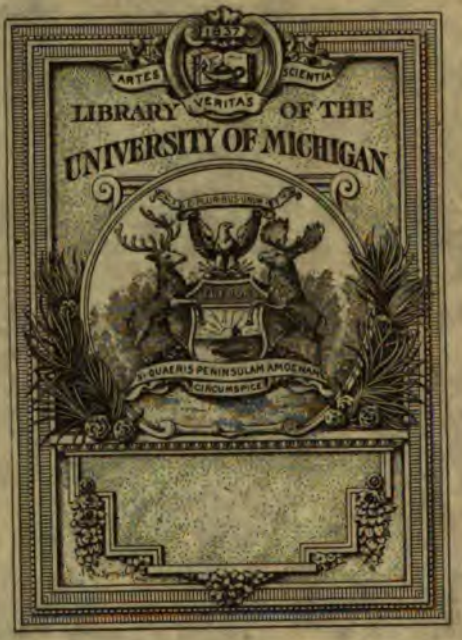

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PROCEEDINGS

OF THE

American Gas Institute

SECOND ANNUAL MEETING

OCTOBER 16, 17, 18, 1907

WASHINGTON, D. C.

PUBLISHED BY THE INSTITUTE

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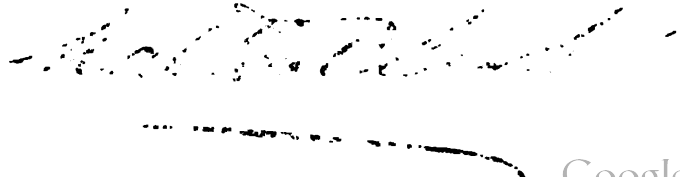

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REPORT OF THE PROCEEDINGS

OF THE

AMERICAN GAS INSTITUTE

SECOND ANNUAL MEETING

HELD AT

THE NEW WILLARD HOTEL, WASHINGTON, D. C.

OCTOBER 16TH, 17TH AND 18TH, 1907.

FIRST DAY.—MORNING SESSION.

The Institute was called to order at 10 a. m., Wednesday, October 16th, in the convention hall of the New Willard Hotel, Washington, D. C., President Walton Clark in the chair.

The following gentlemen were present:

Active Members.

Adams, H. C.....Philadelphia, Penn.
Addicks, Walter R.....New York, N. Y.
Africa, Walter G.....Manchester, N. H.
Allen, William H.....Newark, N. J.
Allison, Walter A.....Philadelphia, Penn.
Ames, Joseph B.....Jersey City, N. J.
Anderson, William C.....Plymouth, Penn.
Baehr, William Alfred.....St. Louis, Mo.
Bailey, W. Frank.....Wilmington, Del.
Bains, George B.....Ardmore, Penn.
Barnes, Albert Mallard.....Cambridge, Mass.
Barrett, William E.....New York, N. Y.
Barrows, George S.....Kansas City, Kan.
Barthold, W. H.....Saginaw, Mich.
Battin, Henry S.....Philadelphia, Penn.
Bayley, C. Clay.....Washington, D. C.
Beack, George W.....Sunbury, Penn.

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Beadle, Albert B.....New York, N. Y.
Beal, T. R.....Poughkeepsie, N. Y.
Bigelow, Arthur F.....Allentown, Penn.
Bill, Benjamin P.....Springfield, Mass.
Boardman, A. E.....New York, N. Y.
Bond, Charles O.....Philadelphia, Penn.
Bradley, Charles W.....Oak Park, Ill.
Brown, E. C.....New York, N. Y.
Brown, R. B.....Milwaukee, Wis.
Bruce, Howard.....New York, N. Y.
Bullock, B. F.....Fredericksburg, Va.
Bump, Milan R.....New York, N. Y.
Burgess, C. F.....Madison, Wis.
Burleigh, John J.....Camden, N. J.
Butterworth, C. W.....St. Albans, Vt.
Butterworth, Irvin.....Detroit, Mich.
Cahill, William J.....Utica, N. Y.
Campbell, S. K.....Plainfield, N. J.
Carter, Robert A.....New York, N. Y.
Castor, William A.....Frankford, Penn.
Cathels, Edmund.....Providence, R. I.
Causbrook, W. R.....Plainfield, N. J.
Chubb, Chester N.....Sioux Falls, S. D.
Clabaugh, G. W.....Omaha, Neb.
Clapp, G. N.....Middletown, Ohio.
Clark, John A.....East Orange, N. J.
Clark, John C. D.....St. Louis, Mo.
Clark, Walton.....Philadelphia, Penn.
Clarey, Edward D.....Burlington, Iowa.
Cline, W. B.....Peekskill, N. Y.
Cobb, S. P.....Rochester, N. Y.
Coggshall, Henry F.....Fitchburg, Mass.
Collins, Carroll .....Marshall, Mich.
Collins, David J.....Philadelphia, Penn.
Combs, Roger B.....Philadelphia, Penn.
Congdon, Richard C.....Atlanta, Ga.
Cook, Charles G.....Trenton, N. J.
Cooper, W. H.....Amsterdam, N. Y.

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Copley, I. C.....Aurora, Ill.
Corscot, John.....Madison, Wis.
Cowdery, Edward G.....St. Louis, Mo.
Cressler, A. D.....Fort Wayne, Ind.
Crisfield, J. A. P.....Philadelphia, Penn.
Crowell, F. B.....Atlanta, Ga.
Cunningham, John H.....Westminster, Md.
Curran, G. W.....Philadelphia, Penn.
Curtis, Samuel P.....Philadelphia, Penn.
Dashiell, P. T.....Newark, N. J.
Dell, John.....St. Louis, Mo.
Dickel, Carl A.....Philadelphia, Penn.
Dickey, Charles H.....Baltimore, Md.
Diffenderfer, J. E.....Steelton, Penn.
Dixson, J. Alfred.....New York, N. Y.
Dods, John C.....Cherryville, Kan.
Doherty, Henry L.....New York, N. Y.
Dolley, George M.....Peru, Ind.
Donahue, E. J.....Jersey City, N. J.
Dorner, William F.....Philadelphia, Penn.
Doty, Paul.....St. Paul, Minn.
Douglas, Henry W.....Ann Arbor, Mich.
Dunbar, James W.....New Albany, Ind.
Dunn, F. S.....Albany, N. Y.
Dustin, Guy K.....Hartford, Conn.
Dutton, Lewis R.....Wyncoke, Penn.
Dutton, R. H.....Hanover, Penn.
Earnshaw, Edward H.....Cincinnati, Ohio.
Eaton, Alfred B.....Chicago, Ill.
Eaton, James B.....Rochester, N. Y.
Egner, Frederick.....Norfolk, Va.
Ellis, Harry.....Camden, N. J.
Ellis, John W.....Providence, R. I.
Enright, F. O.....Frederick, Md.
Evans, George B.....St. Louis, Mo.
Eysenbach, E. E.....Binghamton, N. Y.
Ferguson, B. B.....Portsmouth, Va.
Ferrier, James.....Rome, Ga.

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Fogg, Oscar H.....Flushing, L. I.
Forbes, Charles.....Ottawa, Ont., Canada
Forstall, Alfred E.....New York, N. Y.
Forstall, Walton.....Philadelphia, Penn.
Fowler, Samuel J.....Charlestown, Mass.
Frick, John A.....Reading, Penn.
Frost, William H.....Detroit, Mich.
Fullerton, George.....Schenectady, N. Y.
Fulweiler, Walter Herbert.....Philadelphia, Penn.
Ganser, Herbert H.....Norristown, Penn.
Gardiner, William Howard, Jr.....New York, N. Y.
Gartley, William H.....Philadelphia, Penn.
Gifford, Charles H.....New Bedford, Mass.
Glasgow, Arthur Graham.....London, England.
Glass, Sheldon J.....Milwaukee, Wis.
Golden, John W.....Savannah, Ga.
Goudy, W. R.....Sioux City, Iowa.
Graf, Carl H.....Indianapolis, Ind.
Graham, L. C.....Winona, Minn.
Gribbel, John.....Philadelphia, Penn.
Guffey, Joseph F.....Pittsburg, Penn.
Guldlin, Olaf N.....Fort Wayne, Ind.
Haase, Ewald .....Milwaukee, Wis.
Haines, Jansen.....Des Moines, Iowa.
Hantzmon, H. M.....Alexandria, Va.
Hart, William F.....Washington, D. C.
Hartman, William E.....Joliet, Ill.
Hellen, Frank.....Rochester, N. Y.
Hofmann, Lothar.....Fort Wayne, Ind.
Holden, Thomas F.....Washington, D. C.
Holman, C. L.....St. Louis, Mo.
Holzer, Edwin G.....Easton, Penn.
Humphreys, Alexander C.....New York, N. Y.
Humphreys, J. J., Jr.....Coney Island, N. Y.
Huntting, J. R.....Grand Rapids, Mich.
Hutchinson, F. R.....Camden, N. J.

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Hyde, Henry H.....Racine, Wis.
Johns, L. B.....Hyde Park, Mass.
Johnson, Herbert Gilmore.....Utica, N. Y.
Johnston, Mervyn E.....Newark, N. J.
Jones, Thomas Clive.....Delaware, Ohio.
Jourdan, James H.....Brooklyn, N. Y.
Kellogg, Leonard L.....Sioux City, Iowa.
Kellogg, R. M.....Yonkers, N. Y.
Kennedy, John P.....Cambridge, Mass.
Keppelman, John.....Reading, Penn.
Klumpp, John Bartleman.....Philadelphia, Penn.
Knapp, Amos M.....Peekskill, N. Y.
Knowles, William P.....Richmond, Va.
Lamson, Charles Dudley.....Worcester, Mass.
Lamson, William O., Jr.....Westchester, Penn.
Lane, Frank K.....Richmond, Va.
Lathrop, Alanson P.....New York, N. Y.
Lawlor, R. H.....Waterloo, Iowa.
Lea, Henry I.....Pittsburg, Penn.
Learned, Charles A.....Meriden, Conn.
Learned, Waldo A.....Newton, Mass.
Light, George.....Dayton, Ohio.
Linton, Samuel E., Jr.....Vicksburg, Miss.
Lloyd, Ernest F.....Detroit, Mich.
Loichot, Joseph L.....Canton, Ohio.
Lynn, James T.....Detroit, Mich.
Macbeth, A. B.....Kansas City, Mo.
Macbeth, George T.....Mt. Vernon, N. Y.
Malone, M. E.....Denver, Col.
Mansur, John H.....Royersford, Penn.
Marshall, F. L.....Hopkinsville, Ky.
Mason, John T.....Milwaukee, Wis.
Maxson, J. H.....Gallipolis, Ohio.
McCarter, Thos. N.....Newark, N. J.
McDonald, Donald.....Albany, N. Y.
McDonald, Donald.....Louisville, Ky.
McDonald, William.....Albany, N. Y.
McIlhenny, James S.....Washington, D. C.

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McIlhenny, John.....Philadelphia, Penn.
McIlhenny, John D.....Philadelphia, Penn.
McKay, William E.....Milton, Mass.
Melick, Thos.....Plainfield, N. J.
Merchant, O. A., Jr.....Cape May, N. J.
Merritt, W. H.....Lebanon, Penn.
Middleton, Robert L.....Washington, D. C.
Miller, Alten S.....Baltimore, Md.
Miller, Carroll.....Chicago, Ill.
Miller, Ira Abbott.....Colorado Springs, Col.
Miller, Thomas David.....New Orleans, La.
Miller, V. A.....Canandaigua, N. Y.
Miller, William B.....Birmingham, Ala.
Molony, Martin.....Philadelphia, Penn.
Morehead, John M.....Chicago, Ill.
Morrison, Henry K.....Concord, N. H.
Morris, Robert C., Jr.....Binghamton, N. Y.
Morris, W. Cullen.....L. I. City, N. Y.
Morris, William T.....Ithaca, N. Y.
Morton, F. N.....Philadelphia, Penn.
Moses, Frank D.....Trenton, N. J.
Myers, Joseph B.....Waterbury, Conn.
Nettleton, Charles H.....Derby, Conn.
Newbery, F. E.....Kankakee, Ill.
Norris, Rollin.....Philadelphia, Penn.
Norton, Walter F.....Nashua, N. H.
Nute, Joseph E.....Fall River, Mass.
Nutting, Charles H.....Chicopee, Mass.
Old, George.....St. Augustine, Fla.
Page, Carter H., Jr.....Philadelphia, Penn.
Perkins, Benjamin W.....Altoona, Penn.
Persons, Fred R.....Toledo, Ohio.
Pettes, W. H.....Newark, N. J.
Polk, Roger W.....St. Louis, Mo.
Pollitt, L. Irving.....Erie, Penn.
Pond, E. C.....Petersburg, Va.
Power, John J.....Cumberland, Md.
Pratt, Edward G.....Chicago, Ill.

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Prichard, Charles F.....Lynn, Mass.
Pullen, James T.....Jackson, Miss.
Purcell, Theo. V.....Chicago, Ill.
Quinn, A. K.....Newport, R. I.
Ramsdell, George G.....New York, N. Y.
Randolph, William W.....New York, N. Y.
Rees, Richard.....Memphis, Tenn.
Rice, Henry L.....Aurora, Ill.
Ritter, Charles S.....Detroit, Mich.
Roberts, E. C.....Hackensack, N. J.
Roberts, F. M.....Mt. Vernon, N. Y.
Roberts, George J.....Philadelphia, Penn.
Robison, Charles D.....Nyack, N. Y.
Roohan, Patrick.....SaratogaSprings,N.Y.
Roper, George D.....Rockford, Ill.
Ruegenberg, John M.....Philadelphia, Penn.
Rusby, John M.....Philadelphia, Penn.
Russell, Daniel R.....St. Louis, Mo.
Russell, Herman.....Rochester, N. Y.
Rutter, Thomas V.....New York, N. Y.
Sargent, Fred H.....Lawrence, Mass.
Sawyer, F. H.....Norfolk, Va.
Schmidt, F. W.....Jersey City, N. J.
Scobell, E. C.....Rochester, N. Y.
Searle, Robert M.....Rochester, N. Y.
Secord, Warren L.....Ossining, N. Y.
Shacklette, R.....Adrian, Mich.
Shattuck, John D.....Chester, Penn.
Shepard, Frederick C.....Minneapolis, Minn.
Simons, Keating Lewis.....Birmingham, Ala.
Slade, Richmond E.....Hartford, Conn.
Sloan, J. C.....Port Huron, Mich.
Smart, F. R., Jr.....York, Penn.
Spangenberg, Brewster H.....New York, N. Y.
Spragle, L. D.....Gloversville, N. Y.
Springer, Edward S.....Leavenworth, Kan.
Steinwedell, Carl.....Butte, Mont.
Steinwedell, W. E.....Cleveland, Ohio.

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Stewart, Samuel B.....Pittsburg, Penn.
Stone, Frederick W.....Ashtabula, Ohio.
Strohn, C. B.....Elgin, Ill.
Strohn, R. N.....Aurora, Ill.
Sweetman, M. M.....Kansas City, Mo.
Tait, Frank M.....Dayton, Ohio.
Talbot, Frank .....Danville, Va.
Taussig, J. Hawley.....Philadelphia, Penn.
Terry, H. Warren, Jr.....Mt. Vernon, N. Y.
Thompson, Paul .....Philadelphia, Penn.
Thomson, George W.....Chester, Penn.
Thwing, Orrell O.....Fort Wayne, Ind.
Tippy, Charles W.....Williamsport, Penn.
Tompkins, John P.....Atlantic City, N. J.
Tucker, C. A.....Rochester, N. Y.
Tutwiler, Carrington Cabell.....Philadelphia, Penn.
Wainwright, Arthur V.....South Norwalk, Ct.
Wakeman, E. A.....Glens Falls, N. Y.
Walker, William L.....Fitchburg, Mass.
Walters, Benj. S.....South Bend, Ind.
Waring, George H.....Omaha, Neb.
Welsh, William J.....Stapleton, N. Y.
Wheeler, Fred P.....Syracuse, N. Y.
Whitcomb, H. D., Jr.....Newark, N. J.
White, E. C.....San Antonio, Tex.
Whittaker, Alan Dean.....Paterson, N. J.
Wilkinson, A. L.....Detroit, Mich.
Willard, Fred A.....Rochester, N. Y.
Williams, Herbert G.....Pottstown, Penn.
Williams, Luther S.....Harrisburg, Penn.
Williamson, John.....Chicago, Ill.
Witherby, Edwin E.....New York, N. Y.
Wood, Stuart .....Philadelphia, Penn.
Wood, William Austin.....Boston, Mass.
Wortendyke, I. F.....Janesville, Wis.
Young, Alfred W.....Knoxville, Tenn.
Young, John T.....Muskegon, Mich.
Young, Percy S.....Newark, N. J.

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Young, R. R.....Passaic, N. J.
Zeek, Charles F.....Pensacola, Fla.

Associate Members.

Aikin, Hugh Carlon.....Chester, Penn.
Asendorf, Carl.....Chicago, Ill.
Azoy, Anastasio C. M.....New York, N. Y.
Barnes, George W.....Pittsburg, Penn.
Barnes, William W.....New York, N. Y.
Behringer, Edward A.....New York, N. Y.
Bigelow, Lucius Seymour .....New York, N. Y.
Blinks, Walter M.....Kalamazoo, Mich.
Brill, Alfred P.....Pittsburg, Penn.
Brown, D. F.....Albany, N. Y.
Buckley, John C.....Chicago, Ill.
Carpenter, H. A.....Pittsburg, Penn.
Cartwright, Henry R.....Philadelphia, Penn.
Cheesman, Frank P.....New York, N. Y.
Clifford, Thomas C.....East Pittsburg, Penn.
Corbus, F. G.....Philadelphia, Penn.
Crane, William M.....New York, N. Y.
Cressler, George H.....Fort Wayne, Ind.
Cruse, Arthur R.....Philadelphia, Penn.
Daly, David R.....Jersey City, N. J.
Dickey, Edmund S.....Baltimore, Md.
Fisher, Thomas J.....Washington, D. C.
Fowler, J. Scott.....Philadelphia, Penn.
Frampton, R. C.....Pittsburg, Penn.
Gildersleeve, David H.....W.NewBrighton,N.Y
Graves, George W.....Rochester, N. Y.
Harper, H. D.....Chicago, Ill.
Hayward, E. Bartlett.....Baltimore, Md.
Hayward, Sterling F .....New York, N. Y.
Hobdell, George.....Camden, N. J.
Johnston, E. D.....Connersville, Ind.
Leakey, N. G.....Detroit, Mich.
Leamy, Alan.....Pittsburg, Penn.
Leavenworth, Mark.....Boston, Mass.

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Litle, Thomas J., Jr.....Gloucester City, N. J.
Little, Archibald Stevens Begg.....St. Louis, Mo.
Luqueer, Robert O.....New York, N. Y.
Lush, Joseph.....New York, N. Y.
Mason, Sidney.....Philadelphia, Penn.
Maxwell, Joseph P.....Pittsburg, Penn.
McIlravy, W. N.....New York, N. Y.
Morrell, Clarence P.....Philadelphia, Penn.
Mueller, Robert.....Decatur, Ill.
Nicholas, Carroll B.....Philadelphia, Penn.
Osborne, Willard B.....Pittsburg, Penn.
Parker, George W.....New York, N. Y.
Pattison, Melvin.....Cleveland, Ohio.
Philips, L. R.....Chicago, Ill.
Piser, Theo. H.....Boston, Mass.
Plantinga, Pierre.....Cleveland, Ohio.
Potter, T. J.....West Roxbury, Mass.
Rancke, Louis N.....Baltimore, Md.
Reynolds, M. G.....Anderson, Ind.
Rieka, Edward L.....St. Louis, Mo.
Roberts, Clarence V.....Philadelphia, Penn.
Sayer, Eugene Y.....New York, N. Y.
Schutt, Henry L.....Buffalo, N. Y.
Smith, Arthur M.....Cleveland, Ohio.
Speller, Frank N.....Pittsburg, Penn.
Storrs, Charles P.....Owego, N. Y.
Terhune, Charles F.....New York, N. Y.
Van Wie, Edwin G.....Detroit, Mich.
Wagner, Fred H.....Baltimore, Md.
Warren, Henry J.....Stamford, Conn.
Wells, Fred K.....New York, N. Y.
Wharton, Henry.....Philadelphia, Penn.
Wickham, Leigh.....St. Louis, Mo.
Witherden, George M.....Philadelphia, Penn.
Wood, Edward R., Jr.....Philadelphia, Penn.
Wood, George B.....Philadelphia, Penn.
Young, L. B.....Detroit, Mich.
Zitzewitz, Hermann.....Chicago, Ill.

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Junior Members.

Bache, R. P.....Colorado Springs, Col.
Barnes, H. L.....East Hartford, Conn.
Coombs, Fred S.....Youngstown, Penn.
Eavenson, W. K.....Philadelphia, Penn.
Hutchings, James T.....Rochester, N. Y.
Otten, Charles, Jr.....Yonkers, N. Y.
Parker, Joseph Smith.....Philadelphia, Penn.
Pratt, Edward G., Jr.....St. Paul, Minn.
Willis, Charles M.....New York, N. Y.

ADDRESS OF WELCOME.

THE PRESIDENT: Gentlemen, in calling this Institute to order this morning, I have the pleasure of introducing to you the Hon. H. B. F. MacFarland, Commissioner of the District of Columbia, who will extend to you a welcome to the City of Washington.

MR. MCFARLAND: Mr. President and Gentlemen, I am very much honored in being allowed to speak a word of welcome for the executive government of the District of Columbia. I do not suppose that most of you know what the executive government of the District of Columbia is, but I may say that we are a Board of Commissioners, and that we have the general powers of a government and mayor, with some other powers of a legislative character. We are especially able to represent the sentiment of the community, and on such an occasion as this it is a united sentiment. We have human nature here, as you have it everywhere else, and we are not united upon all things, but upon the occasion of a gathering here of such a representative body as this we are absolutely one in our desire to make you feel perfectly at home. We are fortunate in that the particular arrangements for the hospitality of this occasion are in the hands of some of our citizens who know how to do that sort of thing, and I congratulate you upon these arrangements being in their hands. We wish also to claim the credit for the good weather. If it had been bad weather, I

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should have told you that the weather bureau was under the National Government, but since we have good weather I claim it as belonging to the District of Columbia. We have no keys to present to you, because the gates of the City of Washington are open day and night, and because every American citizen is free-born of this city. This is your national capital, and our national capital. It does not belong to us who live here, although we have a great interest in it, but it belongs to all of the citizens of the republic. It is not strange that national conventions meet here with more and more frequency. It is not strange that this is now a convention city, for there is a special attraction here, and there should be about your national capital, and, if for no other reason, because they are almost always certain to have a larger attendance here than anywhere else. Certainly, every intelligent American wants to visit his national capital at least once a year, and many of them, we are happy to say, come very much oftener than that. He ought to do it and renew his patriotism, because it exalts his just pride as an American to see the home and the symbol of the national sovereignty and of the national power.

In welcoming such a representative gathering as this from every part of the country, having representatives here from almost every large city, as I understand, of the country, we of the government of the District of Columbia feel that we are performing an important service to the national capital itself for it gives us an opportunity to remind you all of your interest, and the interest of the town which you represent in this city, and to remind you what you can do to help forward its development and embellishment and improvement in every respect, until it shall be, as all true Americans hope, I believe, the most perfect capital on earth. Perhaps you know, all of you, that you make the laws and the appropriations for the national capital through your senators and your representatives. We believe that you want those laws and appropriations to be as wise and as generous as possible, and that you will support your representatives in Congress in order that they may aid to make Washington City as it ought to be, one of the beautiful cities of the world. We who live here, we District people, pay

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one-half of the expenses of the maintenance of our national capital. This year we pay about $16.50 per capita, and the rest of you pay the other half, and this year you pay about six and one-half cents per capita. I am sure that you will get your money's worth for all that you have contributed towards the maintenance of the national capital in this one visit alone. I believe that you would willingly, both you and all whom you represent, would willingly double your annual contribution and make it thirteen cents instead of six and one-half cents, and that would add fifty per cent. to the progress of our national capital. Already it has made great progress, as you who come here frequently and see it know, and as you who come here infrequently must have noticed.

In carrying out the arrangements for your entertainment, you will see all possible of the City of Washington, and you will see what progress has been made in beauty and even in wealth. It is not a commercial city, yet the United States census report says that we have more wealth in the District of Columbia than there is in any one of twenty-five specified states, so that there are only twenty states that have more wealth than the District of Columbia, and most of those states are the oldest in the Union. The resources of our financial institutions are in the neighborhood of one hundred millions of dollars, which is high for a non-commercial city. We expect more wealth, although we do not expect to see it as the result of the establishment of a smoke-ridden manufacturing city. We expect to get our increase in wealth without any decrease in beauty, but we expect also greater things than wealth. We expect a full development of beauty in our buildings and grounds, in the parks and in the trees and the monuments, but we expect also greater justice in our laws and our customs, more science, more culture, more religion, so that we shall have here the ideal capital of the world. In all that we ask for the future, we need and expect the aid and sympathy of every patriotic American. (Applause.)

THE PRESIDENT: I will ask Captain McKay to respond to the kind words of welcome by Mr. MacFarland.

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CAPTAIN MCKAY: Mr. President and Commissioner MacFarland: The American Gas Institute sincerely thanks you for the hearty welcome you have extended to us. This Institute is a successful consolidation of three societies of Engineers and Managers; one of these three societies was the American Gas Light Association. When this association first met in Washington, twenty-three years ago, it came quietly and left in silence; when it again convened in Washington, thirteen years ago, it arrived without welcome and escaped without arrest; when, for a third time, the annual meeting was held here in 1904, the association was greeted by the Engineer member of the Board of Commissioners; and behold! to-day, the President of the Board of Commissioners welcomes us with kind words to the marble heart of this monumental city! We appreciate your attention, and we hope to merit the birthright of the freedom of this beautiful and magnificent city.

But the scholarly form of your address reminds me of the historic visit of Queen Elizabeth to Kenilworth, when the Mayor of Coventry asked permission to present an address of welcome. The Mayor, knowing that the Queen was a patron of literature, made the address poetic, and read:

"We men of Coventree
Are very pleased to see
Your Gracious Majestee.
Good Lord! How fine ye be."

But I trust that we shall not experience the sequel, for the Queen smiled, then frowned, and immediately replied:

"My Gracious Majestee
Is very wroth to see
Ye men of Coventree.
Good Lord! What fools ye be!"

This Institute, Mr. President, includes in its active membership men from every state in the Union, from Canada to the North, from America to the South, from every one of our insular possessions, and from the several nations of Europe. We feel at home here in Washington, because each one of us is more or less closely concerned with a Public Service Corporation, and we are becoming familiar with Regulation or Government

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by Commission. In these annual meetings we discuss methods and facts rather than theories; the experience and knowledge of one becomes the property of all; we revert to the original sources of information, and each meeting every year records a reduction in the cost of gas, or an improvement in the service, and a more careful effort to deserve and to retain the confidence and support of the people whom we serve.

Great and important as it is, the Gas Industry is only one hundred years old; among the sixteen thousand words that Shakespeare used, you cannot once find the word "gas," but he knew what the future would bring forth, for he makes Clotea say, in "Cymbeline:" "If Caesar can hide the sun from us with a blanket, or put the moon in his pocket, we will pay him tribute for light." But, Mr. President, we are come to Washington not to demand tribute of our Caesar, but to pay our tribute to the ineffable light of his genius; we believe with Lowell,

> "As one lamp lights another, nor grows less,
> So nobleness enkindleth nobleness."

Here and to Mt. Vernon we are come to learn anew the lessons of courage, of labor, and of patriotism; here, in the capital city of our republic, we are refreshed and inspired by the material evidences of the history, the accomplishments, the greatness, goodness and glory of our country.

Again, Mr. MacFarland, the American Gas Institute thanks you for your cordial greeting, and, like the fellow-countryman of your ancestors, like Robert Burns when he was hospitably entertained, we exclaim:

> "In Heaven itself we'll ask no more
> Than just a Highland welcome."

THE PRESIDENT: The order of business now makes it necessary that you should listen to a Presidential address. I will ask Mr. Prichard if he will kindly take the chair while I am reading.

(Mr. Prichard takes the chair.)

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PRESIDENT'S ADDRESS.

We are assembled here with the burden of proof heavy upon us. We have destroyed three of the most useful organizations of practical and scientific men that have ever existed; we have abandoned the old, simple form of organization, with the old, unpretentious names; we are erecting a new and complex organization, with a name suggestive rather of confidence than of modesty. We are to determine at this meeting how we may justify the destruction we have wrought; what we may do for our industry through the new organization to justify the termination of the high-class, self-sacrificing work of the American, the Western and the Ohio Gas Associations, now dead at our hands.

Seriousness becomes us at this moment. It is not certain that our industry will profit from the change that we have wrought. It is too soon to congratulate ourselves on the success of our efforts, after amalgamation. Now is the time for anxious thought and labor. With painstaking care must we work out our salvation and our justification. This is the concern of all; your directors and officers are not competent to the task. You have honored me with the executive duties of this important meeting; you have thereby increased my responsibilities, but you have not, any one of you, diminished your own. Every man who consented to the death of our old and honored gas associations must feel that personal mortification will follow failure to make this Institute a light and leading among scientific organizations, and a more than worthy successor to the honorable organizations we have destroyed. Indeed, the burden of proof is heavy upon us.

Chief among the duties put upon your President and Directors is the presentation, for your approval or rejection, of such a plan of organization and operation as they believe will enable the Institute to do work useful to our industry and to the state and credible to our membership. Such a plan is included in the report of the Board of Directors to be submitted for your consideration at this session.

The plan that we therein propose to you for the conduct

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of the affairs of this Institute is as simple as appears to us consistent with the expectation of a broader and more valuable work than that of the gas associations. This report is of paramount importance, and should have your careful consideration. If you vote its adoption, and for the constitutional changes it recommends, you commit the Institute to a form of organization and a plan of work far exceeding in complexity and in extent the organization and work of the associations we have abandoned. It is designed to effect what I understand to be the determination of the membership of this Institute, to continue and extend the technical work of the late gas associations, and further to so conduct the affairs of the Institute that it shall be, and be recognized as being, the authority in the United States on all questions relating to the manufacture, distribution and utilization of gas, including the keeping of accounts, and the relations between gas companies and consumers and gas companies and the city and state. There notoriously is need of some authority in these matters. It is possible, by the exercise of care and deliberation, to so place this Institute that it will be universally recognized as an authority to which appeals may be made, with confidence that scientific accuracy and perfect justice will characterize its decisions. The existing agitation on the subject of public service utilities, their charges and service, and the variety of laws, regulations and standards proposed by the various states, indicate the importance of some recognized authority. There can be no doubt that the American Gas Institute is the natural body for such recognition, which we can and must arrange to deserve and to secure.

Your Directors believe that the organization they recommend to you will prove adequate to this end. They are confident that under it the Institute can win and hold the confidence of the profession, and of those of our fellow-citizens who, by reason of their public duties, may be brought into official relations with us. I think no work possible to us is more conducive to the good of the owners of the properties we operate and of the public we serve, and therefore no work that may more profitably or more honorably engage our activities. We can and should establish standards, methods, meas-

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urements and definitions, based upon pertinent and demonstrable fact, and useful in the conduct of our business, the measurement of our service and the determination of questions at issue between the supplier and the consumer of our product. We should as far as practicable, procure for our standards the endorsement of other technical associations and of the scientific organizations of the world. Achievement will be the result of careful and conservative effort. Let us therefore not be in haste to decide or to adopt; but let us consistently and persistently labor toward reasonableness and certainty. So will we achieve our purpose; and make our Institute an instrument for good to our industry, to ourselves and to our fellow-citizens.

At the time of my election to this honorable office I was serving on a committee engaged on an inquiry into the operation of various public service industries, by municipalities,—British and American. You have doubtless read the reports of the committee, and you will soon have an opportunity of reading the record made by the experts employed by them, and analyses of that record, written, one by the advocates of municipal trading and one by its opponents. I do not desire to discuss these matters here; but I want you to know that I come from the long investigation proud of the service American gas companies are rendering, and proud to be numbered among the operators of privately owned American gas works. We know that we have much to learn, and we know that it is poor works in which the wisest of us cannot add to his experience and knowledge; but we have nothing to fear of a comparison with the gas profession of any country; and those of us who are individualists can safely challenge the municipalizer and socialist to a comparison of results, as determined and recorded by the expert investigation of the Civic Federation. You will find that the record of the Commission bears out my statements, and fully justifies the one time advocates of municipal ownership upon that commission in signing, as they all did sign, a report which makes no claim that municipal ownership of gas, electric light, or railways ever has been or ever will be beneficial to the consumer or to the tax-payer.

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There is to-day, in many minds and places, a rage against public service companies and their servants. It is one of the symptoms—the worst—of the disease at present afflicting many of our fellow-citizens, the virulent disease of demagogism. To rail at public service companies, justifying general abuse by citing particular instances of corporate evil doing, is a cheap and easy means of eliciting the applause of the unwary. Men in high places—meaning only to produce ultimate good—are not always wise enough to know that present injustice can never lead to final blessing; and we sometimes find them giving the support of their names and official dignity to the worst form of demagogy—the form that works individual injustice and spreads general distrust like a miasma over the peaceful land. Ultimately, the whole people will suffer from this condition; immediately the owners of public service properties are suffering.

It appears a simple task to differentiate the good from the evil—to punish what evildoers there may be among us, as malevolent citizens, and without prejudice to the great body of honest and able men who are spending their lives, and investing their savings, in efforts to cheapen and improve the public service, and so to deserve and obtain a financial reward. We do not drag the medical profession in the mire, when we learn that some holders of medical degrees are guilty of malpractice. The short yard stick on one tradesman's counter is not accepted as condemnatory of the entire guild of merchants. We are not unreasonable in demanding that occasional corporate misdemeanors, alleged or actual, be not made the basis of suspicion of all corporations.

We who call ourselves "gas men," whether investors or operators, may assert with confidence that we are and ever have been the faithful and useful servants of the public; and that the record shows that no class of citizens, in office or out, has more honorably or more successfully striven in the universal effort to better the condition of mankind. As one result of this effort, this generation has witnessed a reduction in the selling price of our product, in amount greater than is the selling price to-day. In my home city two hundred thousand

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families whose womankind struggled with coal and ashes at the preparation of each meal served twenty years ago, now obtain their cooking fuel without labor, and at a reduced cost to the breadwinner. It is not possible fully to appreciate the social good so accomplished. This improved condition is found in every city, and our generation has not seen so great an amelioration of the condition of the urban population from any other cause. All this has been coincident with a vast extension and improvement in the service we render, and with a marked advance in the cost of nearly every element entering into the production of our product. There is no so-called "unearned increment" here. The reduction in the selling price of gas has been due to the intelligent efforts of our profession to reduce costs, and to extend sales. The increase in the volume of gas sold has come not alone, nor in any great proportion, from the increase in urban population. It has come from the persistent and intelligent efforts of the owners and operators of gas companies to force an extension of the use of gas, partly through improvement in quality and service, but mainly through patiently developing and persistently demonstrating labor-saving and money-saving methods of domestic economy. Our motive, at the worst, has been no worse than the motive of the manufacturer, advertiser and salesman of any labor-saving device—the money-making motive. But as I know you, I know that while the hope of being permitted a share in the financial advantages you have created has had to do with your efforts—the realization of the beneficient character of your work has been to you a gratification and an incentive.

In view of all this, I am not prepared patiently to read and hear criticism and abuse of gas companies. I am not prepared to apologize for the part our industry has had in ameliorating the condition of our race. I am prepared to assert that a fair division of the resulting advantage between the public, by whose consent we have our franchises, and the companies, through whose courage, enterprise and intelligence the advantage has come, would have brought to stockholders of gas properties larger financial returns than they have ever enjoyed. I believe we may reasonably hope that with the passing

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of present misunderstanding will come a helpful knowledge and appreciation of our work. Having confidence in the integrity of our citizenship, we believe that the attitude of the public toward gas companies will be reasonable and well intentioned. We must believe that legislators will recognize that the good of the people demands high-class service from public service companies, and that high-class service can be secured only where such service will earn a commensurate reward. Special effort and the exercise of special intelligence in the service of the public, and in the conservation of the energies of the world, which is itself a service to the public, deserves and requires a special reward. The earnest, painstaking effort—the financial courage that have already made the gas supply of cities a blessing and relief to millions of housekeepers will be adjudged an agency for good, and will be commensurately encouraged and fostered.

To aid in educating the public and their officials, to an appreciation of the services and deserts of gas-supplying companies, is a part of the reasonable duty of this Institute. It lies largely with us to determine the attitude of the municipality and state as relates to our industry. We may place our Institute in a position of dignity and power in the world. We may make it an authority that public officials will recognize and consult to the advantage of our industry, our customers and our fellow-citizens. Or we may through it continue the useful work of the old associations—and be satisfied therewith. It is ours now to decide. If we realize and utilize our opportunity to take our proper place among scientific bodies, if we prove equal to the possibilities before us, and achieve the high destiny that lies available to us, we will have made good in the eyes of men, and the American, the Western and the Ohio Gas Associations of our honorable memory, will not have died in vain.

THE VICE-PRESIDENT: It is customary in bodies of this kind to refer the address of the President to a committee that will report later to the Association whether or not action is necessary on the recommendations he has made. If there is no objection, such usual course will be followed. Hearing none,

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I would name on that committee James T. Lynn, W. E. McKay and R. B. Brown.

(President Clark resumes the chair.)

THE PRESIDENT: The next business in order is the report of the Board of Directors.

The report of the Board of Directors was read by Secretary Dunbar as follows:

REPORT OF BOARD OF DIRECTORS.

WASHINGTON, D. C., October 16, 1907.

To American Gas Institute.

GENTLEMEN:—The Board of Directors has the honor to submit its second annual report as follows:

OCCURRENCES OF PAST YEAR.

Meetings.

Three meetings of the Board have been held during the year, viz., April 10th and September 12th, in New York City, and October 15th, in Washington.

Trustees Gas Educational Fund.

The Trustees of the Gas Educational Fund have, in recognition of the annual contribution of the Institute to the Fund, made the President and Junior Past President of the Institute, Trustees ex officio.

Engineering Societies' Building.

By appointment of the President, Mr. Henry L. Doherty represented the Institute at the dedication of the Engineering Societies' Building, in New York City, on April 16th and 17th.

New York Headquarters.

Rooms 801 and 802 of the Engineering Societies' Building, West Thirty-ninth Street, New York City, have been rented as permanent headquarters for the Institute, for the amount of $1,524 annually.

By-Laws.

By-laws necessary to carry into effect the various provisions of the Constitution have been adopted and sent to the members.

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Bureau of Information.

Believing that the members would be benefited by the ability to obtain fairly prompt information on subjects not clear to them, a Bureau of Information was started in April. The result, as will be seen by the report of the Bureau, has not been particularly encouraging, as for some reason or other the members have made very little use of this agency.

Question Box.

The Board has not appointed any editor for the Question Box, as it is thought advisable to discontinue the Question Box until the present material can be properly revised. It was realized that it would not be possible for the old Board of Revision, in the absence of Dr. Harrop, now living in Brazil, to carry out the revision of the Question Box, and, therefore, the President, by authority of the Board, selected a committee of five men to do whatever work would be possible this year. This committee will report at this meeting. The Board recommends to the Institute, that the Board of Revision be discharged with the thanks of the Institute, especial mention being made of Dr. Harrop, because of his great share in this work.

Affiliation.

The Board has approved a form of agreement drawn up in accordance with Section 55 of the Constitution, providing for the affiliation of all district gas, or gas and electric associations that will sign such agreement, this including the Iowa, Wisconsin and Illinois Associations, whose applications have already been received.

Formation of Sections.

The method of dividing the Institute into sections has been considered by the Board and is still in the hands of a committee which will report to the Board early next year.

Next Place of Meeting.

The President was authorized to appoint a Committee on Next Place of Meeting, and he appointed Messrs. Irvin Butterworth, A. B. Beadle and T. D. Miller.

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Papers Approved.

The following papers have been approved for reading at this meeting:

"Depreciation," by Dr. A. C. Humphreys, New York City.

"The Obligations Imposed by the Possession of a Franchise," by Charles H. Dickey, Baltimore, Md.

"Instruction for Operating Recuperative Benches," by W. A. Baehr, St. Louis, Mo.

"Air Blast Gas Appliances," by W. K. Eavenson, Philadelphia; S. Tully Wilson, Denver, and W. H. Allen, Newark.

"A New Carbonic Acid Gas Indicator," by Charles D. Robison, Nyack, N. Y.

Lecture on "Electrolysis," by Prof. A. F. Ganz, Stevens Institute, Hoboken, N. J.

Report on "A" Meters. Results from Philadelphia, Kansas City, Mo., and Kansas City, Kan.

"Experiences with Dipping Meters."

"Wrinkle Department," by M. R. Bump, Editor.

Also the following committee reports:

Public Policy.

Rates.

Uniform Methods of Taking Candle-Power.

Economic Balance Between Calorific Value and Candle-Power.

Pipe Standards.

REPORTS.

MEMBERSHIP REPORT.

Active Members.

Elected First Annual Meeting	832	
Elected January 3, 1907	29	
Elected January 16, 1907	4	
Elected June 19, 1907	5	
Elected September 25, 1907	45	
Elected October 1, 1907	19	
	—	934

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Transferred from Junior	2		
Transferred from Associate	1	3	
		937	
Deceased	4		
Resigned	3	7	
On Roll October 1, 1907			930

Associate Members.

Elected First Annual Meeting	200		
Elected January 3, 1907	9		
Elected September 25, 1907	9		
Elected October 1, 1907	5		
		223	
Transferred to Active	1		
Deceased	3		
Resigned	1	5	
On Roll October 1, 1907			218

Junior Members.

Elected First Annual Meeting	58		
Elected January 3, 1907	4		
Elected January 16, 1907	1		
Elected September 25, 1907	5		
Elected October 1, 1907	1		
		69	
Transferred to Active	2	2	
On Roll October 1, 1907			67
			1215

Names of Members Elected.

Active Members Elected, January 3, 1907.

Beirne, Edward J. O., Consulting Engineer, Hattiesburgh, Miss., Gas Co., Atlanta, Ga.

Brady, James C., Director, New Amsterdam Gas Co., Westchester Lighting Co., New York, N. Y.

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Bond, Chas. O., Chief Photometrist, Philadelphia Gas Works, The United Gas Improvement Co., Philadelphia, Pa.

Crawford, Thomas, General Manager, Clinton Gas Light and Coke Co., Clinton, Ia.

Davis, Royclen N., Assistant Superintendent, Universal Gas Co., Chicago, Ill.

Dawes, Fred A., President, Gainesville Gas Co., Chicago, Ill.

Diffenderfer, J. G., Manager, Dauphin County Gas Co., Steelton, Pa.

Gibson, William, President, Hamilton Gas Light Co., Hamilton, Canada.

Griffin, John F. Foreman of Appliance Department, Indianapolis Gas Co., Indianapolis, Ind.

Hinds, O. H., Installing Gas Machinery and Managing Le Mars Gas Co., Le Mars, Ia.

Huntting, Joseph R., General Manager, Lebanon Gas and Fuel Co., Lebanon, Pa.

Jones, Thomas J., Manager, El Paso Gas and Electric Co., El Paso, Tex.

Kane, Joseph P., Acting Superintendent, Westchester Lighting Co., Port Chester Dist., Port Chester, N. Y.

Keillor, John, Engineer and Manager, Hamilton Gas Light Co., Hamilton, Ont.

Kelsey, Louis D., Manager, Brookfield Gas, Electric and Heating Co., Brookfield, Mo.

Kircher, Harry B., Superintendent Gas Co., Belleville, Ill.

Lamson, William O., Jr., Manager, Chester County Gas Co., West Chester, Pa.

Leland, F. W., Superintendent, Federal Gas Co., Boulder, Col.

Lockwood, Joseph E., General Manager, Toledo Gas Co., Toledo, Ohio.

McDowell, J. C., General Manager, Kansas Natural Gas Co., Pittsburg, Pa.

Merchant, O. A., Jr., Manager, Cape May Illuminating Co., Cape May, N. J.

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Ruegenberg, John M., Assistant to Superintendent of Works, United Gas Improvement Co., Philadelphia, Pa.

Shaffner, Samuel C., connected with H. M. Byllesby & Co., Owners of Gas Properties, American Trust Building, Chicago, Ill.

Skellenger, Daniel P., General Manager, The Morristown Gas Light Company, Morristown, N. J.

Smith, Elmer W., Superintendent, Gas Co., Kewanee, Ill.

Snyder, Charles S., Assistant District Superintendent, United Gas Improvement Co., Philadelphia Gas Works, Philadelphia, Pa.

Wilson, H. H., Manager, Ft. Madison Gas Light Co., Ft. Madison, Ia.

Wishart, Thomas, Superintendent, Lafayette Gas Co., Lafayette, Ind.

Young, John T., General Manager, Muskegon Traction and Lighting Co., Muskegon, Mich.

Associate Members Elected, January 3, 1907.

Ayers, C. O., Connelly Iron Sponge and Governor Co., Chicago, Ill.

Ellis, A. V., Salesman, Schneider & Trenkamp Co., Division, American Stove Co., Cleveland, Ohio.

Frampton, R. C., Secretary and Treasurer, Rudd Manufacturing Co., Pittsburg, Pa.

Hayward, E. Bartlett, Engineer, Bartlett, Hayward & Co., Baltimore, Md.

Kahn, Julius, Manager, Pennsylvania Flexible Metallic Tubing Co., New York City.

Phillips, L. R., Sales Department, National Tube Co., Chicago, Ill.

Pilz, C., Treasurer, New York Lead Wool Co. (Inc.), New York City.

Speller, Frank N., Metallurgical Engineer, National Tube Co., Pittsburg, Pa.

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Wagner, Fred H., Engineer, Bartlett, Hayward & Co., Baltimore, Md.

Junior Members Elected, January 3, 1907.

Lee, C. W. Vice-President and Treasurer of C. W. Lee Co., Newark, N. J.

Otten, Charles, Jr., Assistant Superintendent, Westchester Lighting Co., Yonkers, N. Y.

Pratt, Edward G., Jr., Assistant to Superintendent of Distribution, St. Paul Gas Light Co., St. Paul, Minn.

Willis, Charles M., Assistant to A. E. Forstall, Consulting Engineer, New York City.

Active Members Elected, January 16, 1907.

Dobbin, G. B., Auditor, Rochester Railway and Light Co., Rochester, N. Y.

Eaton, James B., Purchasing Agent, Rochester Railway and Light Co., Rochester, N. Y.

Hellen, Frank, Superintendent Gas District, Rochester Railway and Light Co., Rochester, N. Y.

Willard, Fred A., Commercial Agent, Rochester Railway and Light Co., Rochester, N. Y.

Junior Members Elected, January 16, 1907.

O'Connell, Charles M., Assistant Inspector Special Appliances, United Gas Improvement Company, Philadelphia, Pa.

Active Members, Elected June 19, 1907.

Bache, R. P., Manager, Colorado Light and Power Co., Colorado Springs, Colorado.

Cohn, Charles M., Secretary, Consolidated Gas, Electric Light and Power Co. of Baltimore, Baltimore, Md.

Grant, Robert, Treasurer, Boston Consolidated Gas Co., Boston, Mass.

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Hutchings, James T., Assistant General Manager, Rochester Railway and Light Co., Rochester, N. Y.

Musil, Louis F., Assistant Engineer, H. L. Doherty & Co., New York City.

Active Members Elected September 25, 1907.

Ames, Joseph B., Superintendent Mains and Services, Public Service Cororation, Jersey City, N. J.

Barker, Wm. S., Assistant to Comptroller, Public Service Corporation, 763 Broad St., Newark, N. J.

Beaumont, Walter W., Assistant Superintendent, Street Lighting Department, The Equitable Illuminating Co., 24 North 22d St., Philadelphia, Pa.

Burleigh, John J., Vice-President, Public Service Corporation, 418 Federal St., Camden, N. J.

Carpenter, Harold Eugene, Superintendent of Construction, The Astoria Light, Heat & Power Co., 142 East 27th St., New York City.

Causbrook, W. R., Agent, Gas and Electric Department, Public Service Corporation, 129 East Front St., Plainfield, N. J.

Chadwell, Wm. H., Superintendent, Market Street Gas Works, Public Service Corporation, Newark, N. J.

Channon, Harry O., Manager, Quincy Gas, Electric & Heat Co., 422 Maine St., Quincy, Ill.

Chewning, Walter L., Superintendent, Front St. Gas Works, Public Service Corporation, Newark, N. J.

Cook, Charles G., Agent, Gas & Electric Departments, Public Service Corporation, 222 East State St., Trenton, N. J.

Cook, Henry R., Jr., Superintendent, Consumers Gas Works, Public Service Corporation, Jersey City, N. J.

Curtis, Geo. W., Superintendent, Camden Coke Works, Gas Department, Camden, N. J.

Dorr, Wm. J., Superintendent Gas Distribution, Los Angeles Gas & Electric Co., 645 South Hill St., Los Angeles, Cal.

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Downey, James N., Assistant Superintendent, Camden Coke Co., Camden, N. J.

Dusenbury, James P., Treasurer, Public Service Corporation, 763 Broad St., Newark, N. J.

Elder, David, Superintendent Construction, Beardstown Gas & Electric Co., Beardstown, Ill.

Ellis, Harry, Superintendent of Distribution, Public Service Corporation, Camden, N. J.

Evans, Owen Brooke, Engineer, The Peoples Gas Light Co., Manchester, N. H.

Foote, Robert Dumont, President, Morristown Gas Light Co., Morristown, N. J.

Fulweiler, Walter Herbert, United Gas Improvement Co., 25th Ward Works, Richmond and Tioga Sts., Philadelphia, Pa.

Gilkyson, Joseph R., General Agent, Gas & Electric Departments, Public Service Corporation, Camden, N. J.

Greacen, W., Jr., Agent, Gas & Electric Departments, Public Service Corporation, 538 Washington St., Hoboken, N. J.

Hanlon, J. P., Agent, Gas & Electric Departments, Public Service Corporation, 263 Central Ave., Jersey City, N. J.

Kennedy, James, Agent, Gas & Electric Departments, Public Service Corporation, 591 Spring St., West Hoboken, N. J.

Kilgour, J. H., Agent, Gas & Electric Departments, Public Service Corporation, 183 Main St., Passaic, N. J.

McCarter, Thos. N., President, Public Service Corporation, Newark, N. J.

Melick, Thomas, Superintendent, Gas Department, Public Service Corporation, Plainfield, N. J.

Millard, Frederick Chas., Superintendent, Gas Manufacture, Los Angeles Gas & Electric Co., 645 South Hill St., Los Angeles, Cal.

Morton, Albert B., Manager, Wakefield Municipal Light Plant, Wakefield, Mass.

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Reynolds, W. E., Agent, Gas & Electric Department, Public Service Corporation, 751 Montgomery St., Jersey City, N. J.

Richards, J. L., President and General Manager, Boston Consolidated Gas Co., 24 West St., Boston, Mass.

Roberts, E. C., General Agent, Public Service Corporation, 114 Main St., Hackensack, N. J.

Roeser, Chas. J., Superintendent, Hoboken Gas Works, Public Service Corporation, Hoboken, N. J.

Russell, Herman, Superintendent, Gas Manufacturing Department, Rochester Railway & Light Co., Rochester, N. Y.

Selig, A. L., General Manager, Gas & Electric Department, The Edison Electric Co., Los Angeles, Cal.

Sherwood, M. S., Agent, Gas & Electric Departments, Public Service Corporation, 226 Springfield Ave., Summit, N. J.

Simons, Keating Lewis, Superintendent, Gas Department, Birmingham Railway, Light & Power Co., Birmingham, Ala.

Swan, Geo. J., Superintendent, Consumers' Light, Heat & Power Co., 214 East 1st St., Topeka, Kan.

Taylor, Jno. Byron, Treasurer, Watertown Gas Light Co., Watertown, N. Y.

Thomas, W. F., Agent, Gas & Electric Department, Public Service Corporation, 392 George St., New Brunswick, N. J.

Thuman, Frederic, Chief Engineer and General Manager, Humphreys & Glasgow, 38 Victoria St., London, S. W., England.

Treleaven, L. G., Manager, Consumers' Light, Heat & Power Co., 824 Kansas Ave., Topeka, Kan.

Wheeler, H. A., Agent, Gas & Electric Departments, Public Service Corporation, 27 West 8th St., Bayonne, N. J.

Wright, Wm. W., Superintendent, Morristown Gas Light Co., Morristown, N. J.

Zingg, J. P., Agent, Gas Department, Public Service Corporation, 458 Bloomfield Ave., Montclair, N. J.

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Associate Members, Elected September 25, 1907..

Bargamin, Clifford, General Manager, Novelty Manufacturing Corporation, 327 28th St., Newport News, Va.

Gunderson, G. B., Secretary & Treasurer, Detroit Stove Works, Detroit, Mich.

Inslee, Chas. L., President, Guarantee Construction Co., 72 Trinity Pl., New York city.

Murdock, C. Bert., Gas Engineer, Pine Bluff, Ark.

Ruud, Edwin, Manufacturer, Ruud Manufacturing Co., Pittsburg, Pa.

Schurz, James R., General Sales Agent, Camden Coke Co., 418 Federal St., Camden, N. J.

Stites, Townsend, General Manager, Welsbach Company, Gloucester, N. J.

Thomas, Richard Henry, General Sales Agent, White & Middleton Gas Engine Co., 107 Liberty St., New York City.

Wilson, Edwards F., Chemist, Irwin, Westmoreland Co., Pa.

Junior Members, Elected September 25, 1907.

Beebe, Thomas Russell, Manager, Stove & Natural Gas Department, The People's Gas Light & Coke Co., 155 Michigan Ave., Chicago, Ill.

Myers, Edward Brittain, Assistant Superintendent, City District, Philadelphia Gas Works, 9th and Dudley Sts., Philadelphia, Pa.

Gilpin, Francis Hopkinson, Assistant, Department of Tests, United Gas Improvement Co., 260 South 15th St., Philadelphia, Pa.

Perkins, Rowan Penrose, Assistant Foreman of Fitters, United Gas Improvement Co., 2005 Delancey St., Philadelphia, Pa.

Wellman, Holley G., Manager, Retort Coke Oven Co., Cleveland, Ohio.

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Active Members, Elected October 1, 1907.

Barnes, Albert Mallard, Treasurer & General Manager, Cambridge Gas Light Co., Cambridge, Mass.

Bertke, William John, Assistant Superintendent, Wyandotte Gas Co., Kansas City, Kan.

Brodnax, Wm. F., Assistant Superintendent, Allentown Gas Co., Allentown, Pa.

Burritt, Dwight F., Superintendent, Springfield Gas Light Co., Springfield, Mass.

Carter, Robert A., Vice-President, Consolidated Gas Co. of New York, 4 Irving Pl., New York City.

Clarke, Joseph, Manager, Cape Girardeau, Mo., Water, Gas & Electric Co., Washington Hotel, St. Louis, Mo.

Covert, Ira C., Superintendent, Gas Department, The Paducah Light & Power Co., Paducah, Ky.

Eves, Philmer, Sales Agent, The Indianapolis Gas Co., Indianapolis, Ind.

Haftenkamp, Joseph P., Assistant Superintendent, Rochester Railway & Light Co., Rochester, N. Y.

Hoffman, Howard, Engineer, South Bend & Mishawaka Gas Co., South Bend, Ind.

James, Robert C., Assistant General Auditor, United Gas Improvement Co., Philadelphia, Pa.

Keene, Alfred M., Auditor, Westchester Lighting Co., Mt. Vernon, N. Y.

Kennedy, John Pendleton, Superintendent, Cambridge Gas Light Co., Cambridge, Mass.

Lyon, Chas. Lumsden, Cadet Engineer, Savannah Gas Co., Savannah, Ga.

Maloney, Andrew P., President, Treasurer & Manager, City Gas Light Co., Ocean City, N. J.; Lakewood Gas Co., Lakewood, N. J., 1530 Land Title Building, Philadelphia, Pa.

Miller, V. A., Superintendent, Canandaigua Gas Light Co., Canandaigua, N. Y.

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Scobell, E. C., Assistant Auditor, Rochester Railway & Light Co., Rochester, N. Y.

Tenney, Albert Ball, General Manager, Malden Electric Co., Malden & Melrose Gas Light Co., Malden, Mass.

Wood, Wm. Musgrave, Superintendent of Distribution, Kansas City, Mo., Gas Co., Kansas City, Mo.

Associate Members, Elected October 1, 1907.

Dudley, Arthur Dean, Esq., United Gas Improvement Co., Philadelphia, Pa.

Koppers, Heinrich, Engineer and Coke Oven Contractor, Joliet, Ill.

Little, Archibald Stevens Begg, Engineer, Missouri Fire Brick Co., St. Louis, Mo.

North, F. S., Treasurer and General Manager, Suffolk Gas & Electric Light Co., Bay Shore, N. Y.

Owens, Harry Thurston, Inspector of Lamps and Gas, 13 Park Row, New York City.

Junior Members, Elected October 1, 1907.

Flowers, Dean Wilcox, Chemist, Binghamton Gas Works, Binghamton, N. Y.

TRANSFERS OF MEMBERSHIP.

From Junior to Active, September 25, 1907.

Morgan, Jno. Eyre, Superintendent, Savannah Gas Co., Savannah, Ga.

From Junior to Active, October 1, 1907.

Frick, John A., Superintendent, Savannah Gas Co., Savannah, Ga.

From Associate to Active, October 1, 1907.

McDonald, Donald, Director, Erie Gas Co., Erie, Pa. Albany, N. Y.

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Deceased.

Active.

A. C. Pease, Lowell, Mass., January 3, 1907.
James Blake, Cahoon, New York, N. Y., February 16, 1907.
James K. Bowen, Schuylkill Haven, Pa., March 19, 1907.
J. O. Johnston, Columbus, Ohio, April 21, 1907.

Associate.

John S. Wilbraham, Philadelphia, Pa., July 2, 1907.
Thomas B. Riter, Pittsburg, Pa., April 23, 1907.
A. S. Mallory, New York, N. Y., August 9, 1907.

Resigned.

Active.

Aaron K. Stiles, Streator, Ill.
Edwin M. Walker, Bristol, Tenn.
J. S. Whittaker, Portsmouth, N. H.

Associate.

H. A. Galt, Barberton, Ohio.

Treasurer's Report.

Receipts.

Dues	$9,205.00
Initiation Fees	395.00
J. W. Dunbar, Secretary (for detail, see below)	113.87
Ohio Gas Light Association	180.91
Gas Journals, Report First Annual Meeting	53.92
Western Gas Association	117.70
American Gas Light Association	2,000.00
Badges (for detail, see Badge Report below)	805.00
Total	$12,871.40

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Expenditures.

Progressive Age Publishing Co., Advertising	$60.00
J. W. Dunbar, 3½ months' salary as Acting Secretary and Treasurer	350.00
Reporting First Annual Meeting	236.34
Trustees Gas Educational Fund	350.00
Western Gas Association, money advanced J. W. Dunbar, Acting Treasurer	900.00
Refund of Initiation Fees on account of membership in old associations	45.00
Ashmead, Clark & Co., Diplomas	126.00
T. E. Crossman, Reporting Directors' Meeting	47.66
The Tribune Company, Proceedings	3,847.60
Express and Postage for Proceedings	565.89
Spahr & Glenn, Directory of Membership	288.75
The Ledger Company, Abstracts	1,441.50
J. H. Johnston & Son, Badges	1,531.02
Printing, Stationery, Postage, Supplies, etc.	1,114.37
J. W. Dunbar, Secretary, Expenses attending Directors' Meeting	69.25
Rent of Office in Engineering Societies' Building, 3 months	381.00
Stuart Crane, Services as Stenographer to the Secretary	450.00
Miss L. P. Chapman, Clerical Services for the Treasurer	71.11
Balance on hand, as per certified check	995.91
Total	$12,871.40

FINANCIAL REPORT OF SECRETARY
FROM JULY 16, 1906, TO OCTOBER 13, 1906.

Receipts.

Borrowed from Western Gas Association	$400.00	
Membership Fees	195.00	
Dues	270.00	
		$865.00

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Disbursements.

Railway Passenger Association	$20.25	
Wrinkle Department	72.18	
Postage	250.90	
Stenographer and Clerk	90.80	
Stationery, Printing and Supplies	41.70	
Telegrams	2.80	
Invitations and Badges	179.70	
Total Expenditures	$658.33	
Cash in Treasury October 13, 1906	206.67	
		$865.00

FINANCIAL REPORT OF SECRETARY

FROM OCTOBER 13, 1906, TO NOVEMBER 7, 1906.

Receipts.

Borrowed from Western Gas Association	$500.00	
Returned from Passenger Associations	20.35	
Membership Fees collected	140.00	
Membership Dues collected	115.00	
Balance Cash on hand October 13, 1906	206.67	
		$982.02

Disbursements.

Stationery and Sundry Printing	$97.75	
Expenses Chicago Meeting	71.45	
Freight and Telegrams	16.90	
Clerk hire	86.00	
Drawings, Cuts and Electrotypes for 1906 papers	66.80	
Printing Constitutions	57.50	
Membership List	107.75	
Printing Papers, October meeting	364.00	
Balance remitted to T. C. Jones, November 7th, 1906	113.87	
		$982.02

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Secretary's Badge Report, September 1, 1907.

Badges received Jan. 26 to Sept. 1, 1907	432	
Badges sold to Sept. 1, 1907	227	
Badges on hand Sept. 1, 1907		205

Received for Sale of Badges.

227 badges at $3.75 each	$851.25	
Engraving on badges	35.68	
		$886.93

Disbursements.

Remitted to T. C. Jones, Treasurer	$805.00	
Registry stamps purchased	22.50	
Stamps received as purchase price and used by the Institute	3.01	
Cash balance in hands of Secretary September 1, 1907	56.42	
		$886.93

Approved,

T. C. Jones,
Charles F. Prichard.

Secretary's Report on Volume I, Proceedings of the American Gas Institute for the 1906 Meeting—September 1, 1907.

Volumes received from printer	1,700	
Returned from members	5	
		1,705
Sent to Members	1,145	
Exchange list	3	
Sold	9	
On hand	548	
		1,705
Sale of 9 Volumes of Proceedings	$50.00	
Sale of Abstracts	2.00	
		$52.00
Amount to credit of Institute in hands of Secretary		$52.00

Approved,

T. C. Jones,
Charles F. Prichard.

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Estimate of Receipts and Expenses From September 1, 1907, to September 1, 1908.

Receipts.

Dues: 1,050 Active and Associate; 75 Junior	$10,875.00	
Initiation Fees: 100 Active and Associate; 10 Junior	1,550.00	
Sale of Surplus Badges	700.00	
Sale of Reports and Proceedings	200.00	
Received from American Gas Light Association	798.60	
Received from Gas Congress	120.41	
Total estimated receipts	$14,244.01	
Balance on hand Sept. 1, 1907	995.91	
		$15,239.92

Expenses.

Rent of Headquarters	$1,524.00	
Salary of Secretary and Treasurer	3,000.00	
Clerical Assistance	1,000.00	
Abstracts	1,000.00	
Annual Meeting, Reporting and Publishing	3,800.00	
Sundry Printing and Postage	1,500.00	
Directors' Meetings	200.00	
Gas Educational Fund	350.00	
Salary of Secretary, 1906-1907	1,200.00	
Sundries	1,000.00	
Total	$14,574.00	
Estimated balance October 1, 1908	665.92	
		$15,239.92

RECOMMENDATIONS.

Abstracts.

During the past year the members have received three sets of abstracts covering publications of interest to the gas profession. These abstracts have been selected by the Secre-

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tary from a collection furnished him by The United Gas Improvement Company.

This Company has agreed to continue this practice during the coming year. The Board recommends that the issuance of the abstracts be continued.

Exhibition Room.

The Board recommends that at future meetings a large room be provided for any exhibits of apparatus and appliance, which manufacturers desire to make. The control and arrangement of this exhibition space should rest with the Institute, preferably the Committee on Arrangements, in connection with the Technical Committee to be spoken of later on. Through the provision of such space and every other possible way, the Institute should afford the manufacturers an opportunity of acquainting its members with their products.

Transfer and Cessation of Membership.

The Board recommends an amendment to the Constitution, giving the Directors power to change the grade of membership of any member no longer eligible to the grade to which he belongs, or in case he is no longer eligible to any grade, to terminate his membership.

Listing of Members.

The Board recommends an amendment to the Constitution providing that every member should be listed on the Institute rolls and lists of membership by the title, or titles only from which he derives his eligibility to this class of membership.

New Organization.

Being thoroughly convinced of the necessity for a change in the organization of the Institute, in order to better fit it for the work that awaits it, the Board recommends certain changes in the Constitution to obtain an organization substantially as follows:

PRESIDENT.—He will preside at all Institute meetings wherein the members meet as one body, to hear the Presi-

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dential address, to elect officers, to conduct any other business of the Institute, and to consider such papers and questions as in the judgment of the Directors should be brought before a general meeting. He will be ex-officio a member of every committee and sub-committee.

SECRETARY AND TREASURER.—There should be one person, a salaried officer, combining both these offices and with duties as now prescribed by the Constitution.

DIRECTORS.—Number and powers as now prescribed in the Constitution. This insures that all committee reports and decisions shall receive the approval of the Directors before public discussion or publication. The Directors also control all appropriations.

COMMITTEES.—To ensure quality, as well as quantity, and a unity of purpose, the oversight of the work should be in comparatively few hands. To accomplish this end, the Board recommends that there be two general committees, viz.—Technical Committee and Public Relations Committee—each committee to be composed of six members, to be appointed by the President each year, and to serve for one year. In general, every question which had a bearing on the relations of a company to the public, or to any governing body, would be considered by the Public Relations Committee. The Technical Committee would devote its especial attention to the prosecution of research work, and to securing papers for the meetings. Every resolution of the Institute for the investigation of any question, whether as the result of the reading of a paper or not, would be referred by the President to whichever of these committees it would naturally belong. Whenever either committee thought it advisable, a sub-committee would be appointed, a member of the general committee being chairman, and the other members being selected from the Institute membership. This sub-committee would exist at the pleasure of the general committee, to which its report would be made.

If the membership of these two committees be properly chosen, they will, in connection with a Secretary, devoting his

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entire time to Institute work, effect a marked improvement in the latter. Instead of, as at present, papers coming in each year too late to be properly considered before going to press, and the meeting program a miscellaneous collection of subjects, it is possible to imagine a program thought out a long time in advance, each paper more or less a supplement of the other, and in the hands of the committee several months before the meeting, to enable careful consideration and possible revision.

With the organization as above outlined, there will be far less danger, than now exists, of ill-considered papers, and discussion becoming embodied in the proceedings, and of hasty action on questions, whether of technical nature or affecting public relations. Notwithstanding this, the Board recommends that any resolution, recommendation or report, that has not been considered and approved by the Directors, and that, in the opinion of the Chair, would have the effect of changing the policy of the Institute, or committing it to any new policy or opinion to which it had not theretofore been committed, should be referred by the Chair, before adoption, to the Board of Directors to report at the next regular Institute meeting.

The Board believes that there are some things that should not be discussed at the Institute meetings, except in executive session. It also recommends the formation of a Publication Committee to be the sole judge of what shall appear in the Proceedings.

The necessary changes in the Constitution are as follows:

The insertion of a new Section 21, to wit:

Sec. 21. The Directors may transfer any member from his then present to any lower grade of membership. They may also refuse to receive the dues of any member who is no longer eligible to any grade. No transfer of grade shall be made, or refusal to accept dues recorded, except upon notice from the Secretary, whose duty it shall be to give such notice that said member is no longer eligible for membership in his then present grade, and that said member has for a period of ninety days after notification of such non-eligibility, failed to

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apply for transfer. The vote in each case shall be by ballot, and shall require two-thirds of the votes cast for its adoption.

Renumbering of present Section 21, new number to be 22.
Renumbering of present Section 22, new number to be 23.
Renumbering of present Section 23, new number to be 24.
Renumbering of present Section 24, new number to be 25.
Renumbering of present Section 25, new number to be 26.
Renumbering of present Section 26, new number to be 27.
Renumbering of present Section 27, new number to be 28.
Renumbering of present Section 28, new number to be 29.
Renumbering of present Section 29, new number to be 30.
Renumbering of present Section 30, new number to be 31.
Renumbering of present Section 31, new number to be 32.
Renumbering of present Section 32, new number to be 33.

Amending present Section 33 to read as follows:

Sec. 34. The President shall take the chair at all meetings of the Institute, of the Board of Directors and of committees at which he is present. He shall determine to which general committee any matter shall be referred.

Renumbering of present Section 34, new number to be 35.
Renumbering of present Section 35, new number to be 36.
Renumbering of present Section 36, new number to be 37.
Renumbering of present Section 37, new number to be 38.

Amending present Section 38 to read as follows:

Sec. 39. The duties of the Directors shall be to have the general management of the affairs of the Institute, and to prepare for its meetings. No paper or report that has not had the approval of the Directors shall be read at any meeting.

The Directors shall have the power to appoint from time to time a Committee on Arrangements from among the members to assist the Board of Directors in arranging for the meetings of the Institute. The Directors shall have power to fill for the unexpired term any vacancies occurring by death, or resignation, in their own number, or in the general committees.

Any resolution, report or recommendation, that has not been considered and approved by the Directors, and that, in

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the opinion of the Chair, would have the effect of changing the policy of the Institute or committing it to any new policy or opinion to which it had not theretofore been committed, should be referred, before adoption, to the Board of Directors, whose duty it shall be to report to the next regular meeting of the Institute upon such committal, if any, and its proper phrasing.

The insertion of a new Section 40, to wit:

Sec. 40. There shall be two general committees, each reporting to the Board of Directors and responsible to the Board for such part of the work of the Institute as is delegated to it in accordance with the provisions of Sections 34, 41 and 42. Each committee shall be composed of six members, to be appointed each year by the President, and to serve one year.

The insertion of a new Section 41, to wit:

Sec. 41. One general committee shall be called the Public Relations Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind affecting the relations between the Institute, or its members, and the public, or any governing bodies, except as herein provided.

The insertion of a new Section 42, to wit:

Sec. 42. One general committee shall be called the Technical Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind having to do with the construction, operation and extension of gas works, and the conduct of the affairs of gas companies, not specifically delegated to the Public Relations Committee by Section 41, and except as herein otherwise provided.

The insertion of a new Section 43, to wit:

Sec. 43. Each general committee shall have the power to appoint sub-committees. Each sub-committee shall consist of one member of the general committee, the other members being taken from the general membership of the Institute, and shall exist at the pleasure of the general committee by which it was appointed, and to which its report shall be made.

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Renumbering of present Section 39, new number to be 44.
Renumbering of present Section 40, new number to be 45.
Renumbering of present Section 41, new number to be 46.
Renumbering of present Section 42, new number to be 47.
Renumbering of present Section 43, new number to be 48.
Renumbering of present Section 44, new number to be 49.
Renumbering of present Section 45, new number to be 50.
Renumbering of present Section 46, new number to be 51.
Renumbering of present Section 47, new number to be 52.

The insertion of a new Section 53, to wit:

Sec. 53. The President, the Vice-Presidents and the Chairmen of the two general committees shall constitute a Publication Committee, and nothing shall be included in the published reports of the Institute's proceedings, or in any other publication issued by its authority, that has not been approved by at least two-thirds of the full membership of the Publication Committee.

Renumbering of present Section 48, new number to be 54.

Amending of present Section 49 to read as follows:

Sec. 55. The Board of Directors may, in its discretion, make, with any one (or each) of the district and state gas, or gas and electric associations, now existing or hereafter to be formed, that will agree thereafter not to elect to voting membership any person connected in any way with the gas industry who is not directly identified with gas, or electric, interests within the district or state whose name it bears, to consult with the Institute before undertaking any original work of interest to the gas profession, and to do each year, under the direction of the Institute, a certain amount of original work, agreements for co-operation between the Institute and such associations. Each and every district or state gas, or gas and electric, association, with which such agreements are entered into shall be entitled to elect one of its members a member of the Board of Directors of the Institute, the member so elected to be in addition to those named in Section 23, provided that the number of such associated directors shall never exceed one-third of the total membership of the Board. Should the Board of Directors

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provide for an executive committee, this committee shall include in its membership one man from each of the affiliated associations as long as the number of such associations does not exceed six. Thereafter there shall be on the executive committee at least six men who are members of affiliated associations and have among them membership in at least six such associations.

The amending of present Section 50 to read as follows:

Sec. 56. Each member of the Institute in good standing shall be entitled to and shall be furnished by the Secretary with a copy of the Proceedings of the Institute for the current year, in which shall be listed the names and addresses of the members. In any such list each member shall be listed by the title, or titles only from which he derives his eligibility to his class of membership.

Renumbering of present Section 51, new number to be 57.

JAMES W. DUNBAR, Sec'y.

DISCUSSION.

THE PRESIDENT: Gentlemen, the report of the Board of Directors is before you for action.

MR. COWDERY: Mr. President, I move you that the report of the Board of Directors be received, printed in the Proceedings, and that all its recommendations not involving a change in the Constitution be approved, and that the Secretary cast the ballot of the Institute for the proposed amendments to the Constitution.

MR. A. E. FORSTALL: Second the motion.

THE PRESIDENT: Gentlemen, you have heard the motion. Are you ready for the question?

MR. EGNER: Mr. President, I think that the matter of changing the Constitution is a very serious one. If I understand aright, the Secretary is to cast the ballot for the proposed amendments. I think those proposed amendments to the

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Constitution should be printed and sent to the different members so that they may vote on them by ballot. I certainly hope that that motion will not prevail, that the Secretary cast the ballot for the amendments to the Constitution without further consideration or submission to the members. I have listened to them very attentively, and there are some changes proposed there which I would like the opportunity to consider. I hope that the motion will not prevail.

THE PRESIDENT: I will say for Mr. Egner's information that we could not take a letter ballot on the amendments of the Constitution. The Constitution itself forbids that. I think the changes that are proposed are very simple, are readily understood, and the changes that are proposed are necessary to carry into effect the recommendations that the Board has made for the enlargement of the work of the Institute.

MR. BOARDMAN: Mr. President, I notice in the recommendations one to consolidate the office of the Secretary and Treasurer. I would ask for information, if the Secretary-Treasurer's office is supposed to be a bonded office. I did not hear anything mentioned in the recommendations about that, and I think it is very necessary that he should be a bonded officer. Unless that is contemplated, I would like to make an amendment to that proposition.

SECRETARY DUNBAR: I will say that the By-laws which were adopted by the members of this association through a mail ballot provide for the bonding of the Treasurer in a guarantee company, the association to pay the premium on the same.

THE PRESIDENT: All in favor of the adoption of the resolution of Mr. Cowdery, seconded by Mr. Forstall, please say "Aye." Contrary minds, "No." Carried.

The Secretary, as instructed by the Institute, will please cast the ballot for the proposed amendments to the Constitution.

SECRETARY DUNBAR: Mr. President and Gentlemen, complying with your instructions, I vote for the changes in the

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Constitution that you have just heard read in the report of the Board of Directors.

The vote cast by the Secretary certified by Mr. A. G. Glasgow and Mr. Paul Thompson, tellers.

THE PRESIDENT: The next business is the report of the Trustees of the Gas Educational Fund.

NINTH ANNUAL REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND TO THE SUBSCRIBERS TO THE FUND.

To the Subscribers to the Trustees Gas Educational Fund:

GENTLEMEN:—The Trustees appointed at the Twenty-sixth Annual Meeting of the American Gas Light Association, held October 17th, 1898, to administer the Educational Fund formed by your subscriptions, submit the following report as to the work done from October 1st, 1906, to September 30th, 1907.

The work has been carried on along the same lines as in previous years, and the number of students in the practical class has, as before, averaged about 100. This membership is maintained, without any attempt to bring the class to the notice of the persons eligible for membership, largely through the recommendation of the work given by former students to their associates. Judging from previous experience, if any effort were made to call attention to the work of the class, the number of applications would increase far beyond the limit of 150 set for the maximum membership on account of the inability to pay for the full time of a man qualified to take charge of the class work. With regard to the qualifications required in such a man it is to be considered that the mere preparation of the Trustees' answers to the questions sent out to the class is the smallest and least exacting part of the work. Each set of answers sent in by a student is gone over carefully and criticised, and in order to make the criticisms valuable to the students, it is necessary that the man in charge of the work shall have a sufficiently wide knowledge of types of apparatus

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and methods of operation in use all over the United States, and also a sufficient acquaintance with the literature available for the students to enable him to determine whether or not the students are writing from actual experience, from knowledge obtained through reading, or are merely making a guess at the answer. It can be readily seen that the criticism would be very different according to the method employed by the student in preparing his answers.

It could hardly be expected that the whole time of a man with so wide a knowledge of conditions could be secured for $3,000 per year, especially when it is remembered that out of this he must pay for a stenographer and also a not inconsiderable proportion of the office rent, so that at the outside he does not have left for himself more than $2,000 per year.

It is very much to be desired that we should be in a position to employ a competent secretary who could give his full time to the work of the position, and therefore it is also much to be desired that the subscriptions to the fund be materially increased.

The payment now due on the subscriptions is the final one of the five-year period for which most of them were made, and each subscriber is earnestly requested not only to renew his former subscription but to use his utmost endeavors to secure further subscriptions from his friends who are financially interested in the gas business and consequently benefit by the work of the Trustees.

The work of publishing in a single volume all of the answers sent out to different sections of the class has been delayed partly by an attempt to learn whether or not there were any figures for the weights per cubic foot, the calorific value and other properties of gases which were recognized as being correct by any properly constituted authority in the United States, and partly owing to the inability of the Secretary to devote the necessary time to this part of the work. This work will be pushed as rapidly as possible.

In view of the fact that the American Gas Institute has assumed the subscriptions previously made by the American Gas

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Light Association and the Western Gas Association it has been provided that the President and the Junior Past President of the Gas Institute be Ex-Officio Trustees, as was the case with the same officers in the American Gas Light Association.

During the year, eighteen members of the Section of 1907 finished their course and their connection with the class ceased, while the Section of 1910 started work on January 2d, 1907, with a membership of forty-three.

The number of members in each section at the beginning of the year, and the changes that have taken place during the year, and the names of the members of the class who have completed the course during the year, are shown in detail on the Secretary's report, which is appended.

The Section of 1908 now contains seventeen members, the Section of 1909 twenty-four, and the Section of 1910 fifty-five, making the total membership in the regular class ninety-six. Three special students are receiving the questions and answers with the Section of 1909 and one with the Section of 1910.

The card index of the principal articles published in the American Gas Light Journal, Progressive Age and the Journal of Gas Lighting has been kept up during the year.

It may be advisable to remind the subscribers that in connection with the office of the Secretary, there is a room which is available for their use, in case, when visiting New York, they wish to make appointments with other non-residents and do not care to make these appointments at their hotel.

The Treasurer's report, which is appended, shows the total amount of subscriptions to date, the available income and expense for the year, a summary of the cash account and the statement of the amount of the surplus fund and the securities in which it has been invested.

The Surplus Fund is made up of a contribution of $1,000, of subscriptions paid in in advance of the time when they are due, of unexpended balances and of interest received on investments. The proper proportion of the advance subscriptions will, of course, be drawn out each year to meet expenses, but the unexpended balances and the interest will accumulate into

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a fund which will be available to assist in carrying on the work in case all the present subscriptions are not renewed when they expire.

Respectfully submitted,

Trustees Gas Educational Fund,
WALTON CLARK,
Chairman.
ALFRED E. FORSTALL,
Secretary.

SECRETARY'S REPORT FOR YEAR ENDING SEPTEMBER 30, 1907.

	Section of 1907.	Section of 1908.	Section of 1909.	Section of 1910.	Special Class. 1909.	Special Class. 1910.	Total.
Members enrolled October 1, 1906	22	21	42		4		89
Entered Class January 1, 1907				43		1	44
Additions to Class since January 1, 1907				45			45
Reinstated in Class during year		1	1				2
	22	22	43	88	4	1	180
Resigned during year	1	1	1	6			9
Dropped from Class during year	3	4	18	27	1	53	
Finished course during year	18					18	
	22	5	19	33	1		80
Total enrollment September 30, 1907		17	24	55	3	1	100
Applications on file for admission to class Jan. 1, 1908							13

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Names of Students who Completed the Three Years' Course with Section of 1907.

Wm. J. Baker, Janesville, Wis.
Thos. R. Beebe, Chicago, Ill.
Samuel W. Brown, Waterbury, Conn.
Oscar H. Bundy, New York, N. Y.
Michael B. Burns, Little Falls, N. Y.
L. Holland Cook, Tonawanda, N. Y.
Amos M. Knapp, Peekskill, N. Y.
Frank C. McCormack, San Francisco, Cal.
A. F. Mueller, Seattle, Wash.
Harry E. Odeneath, Philadelphia, Pa.
Chas. J. O'Donnell, Philadelphia, Pa.
John C. Parker, Philadelphia, Pa.
Clifford D. Shaul, Houston, Texas.
C. H. Stevick, Long Island City, N. Y.
Theo. R. Sucher, New Haven, Conn.
C. J. Weinmeister, Atlanta, Ga.
Charles Wilde, Colwyn, Pa.
Harry H. Wilson, Fort Madison, Iowa.

In addition to these, A. S. Quackenbush, Rockford, Ill., R. J. Ritchie, Plattsmouth, Neb., Rudolph Schmitt, Kingston, N. Y., and Lovell J. Wicker, Detroit, Mich., answered all except the last two sets of questions.

Treasurer's Report for Year Ending September 30, 1907.

Condition of Subscriptions.

		For Year 1906-1907.
Total of old subscriptions holding over from original five-year period .	$92.58	$92.58
Total new subscriptions reported September 30, 1906 . . .	23,046.00	4,609.20
Subscriptions received since that date .	405.00	81.00
	$23,543.58	$4,782.78

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Less amounts discontinued or unpaid on account of death of subscribers	$860.00		
Not considered good	100.00		
		960.00	195.00
Total to October 1, 1907		$22,583.58	$4,587.78
Received from subscribers during year		$4,291.00	
Payments not applicable to year		479.00	
Total paid in by subscribers since September 30, 1906, and available for year		$3,812.00	
Paid in previous to current year on account of 1906-1907 subscriptions		550.78	
Total paid in by subscribers available for this year		$4,362.78	
Still to be paid for this year		225.00	
Total subscriptions available for year			$4,587.78
Dues received for membership in Special Class			10.00
Sale of thirteen sets of questions and answers for one year			65.00
Sale of three sets of questions and answers for one year, less 10% to book dealers			13.50
Total amount available for year			$4,676.28

Statement of Income and Expenses.

Total amount available for year		$4,676.28

Expenses.

Secretary's salary	$3,000.00	
Office rent	300.00	
Printing, stationery, postage, etc.	570.82	
Cuts used in illustrating answers	14.34	
Periodicals and binding	12.48	
Fire insurance on books	12.18	
Total expenses paid to October 1, 1907	$3,909.82	

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Add for expenses incurred, but unpaid:			
Printing, stationery, postage, etc. . . .	$72.25		
Cuts used in illustrating answers . . .	3.90		
		$76.15	
Total expenses for year . .			$3,985.97
Balance			$690.31
Depreciation on furniture . .			16.05
Surplus on year's operation . .			$674.26

Cash Account.

Received from subscribers since September 30, 1906, Current Fund .	$4,291.00	
Interest for one year on $2,000 Binghamton Gas Works 1st mortgage 5% bonds	100.00	
Interest for one year on $1,500 Atchison, Topeka & Santa Fe Railroad general mortgage 4% bonds . .	60.00	
Interest for one year on $1,000 Omaha Gas Company 1st mortgage 5% bonds	50.00	
Interest for one year on $1,500 New Gas Light Company of Janesville 1st mortgage 5% bonds (guaranteed by The United Gas Improvement Company)	75.00	
Interest on deposit in Knickerbocker Trust Co.	112.75	
Sales of questions and answers (for items see above) . . .	78.50	
Dues received for membership in Special Class	10.00	
Total receipts for year . .	$4,777.25	
Cash balance from last year . .	1,370.88	
Total to account for . .		$6,148.13

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Expenses for year paid . .	$3,909.82	
Furniture (bookcase units) . .	25.75	
Total paid out. . . .		$3,935.57
Balance		$2,212.56
Balance in Knickerbocker Trust Co., as per pass book . . .	2,192.56	
Cash on hand	20.00	
		$2,212.56

Surplus Fund and Investment.

Amount paid in by subscribers in advance .	$1,024.20
" " " " to Surplus Fund	1,000.00
Unexpended balance from 1898-1899 . .	1,330.99
" " " 1899-1900 . .	397.70
" " " 1900-1901 . .	343.71
" " " 1901-1902 . .	211.88
" " " 1902-1903 . .	359.89
" " " 1903-1904 (after deduction of cancelled subscriptions previously included)	225.88
Unexpended balance from 1904-1905 (after deduction of cancelled subscriptions previously included)	481.38
Unexpended balance from 1905-1906 (after deduction of cancelled subscriptions previously included)	529.10
Interest on bonds to date . . .	1,662.22
Interest on deposit in Knickerbocker Trust Company	261.49
	$7,828.44

Already Invested.

$2,000 Binghamton Gas Works 1st mortgage 5% bonds .	$1,930.00
$1,500 Atchison, Topeka & Santa Fe R.R. general mortgage 4% bonds	1,513.75

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$1,000 Omaha Gas Co. 1st mortgage 5% bonds . .	$1,000.00	
$1,500 New Gas Light Company of Janesville 1st mortgage 5% bonds (guaranteed by The United Gas Improvement Company) . . .	1,500.00	
Furniture	142.54	
		6,086.29
		$1,742.15

New York, October 11, 1907.

We, the undersigned members of the Finance Committee of the Trustees Gas Educational Fund, have this day examined the books and accounts of William R. Beal, Treasurer, for the year ending September 30, 1907, and have found the same to be correct, and the above balance of $2,192.56 to be in the bank.

ALEX. C. HUMPHREYS,
W. F. DOUTHIRT,
Finance Committee.

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APPENDIX TO REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND.

(This appendix was not read at the meeting.)

SEVENTH SERIES OF QUESTIONS—SECTION OF 1908, PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. What is crude oil? What is naphtha? What is gas oil?

2. It is desired to "let down" a bench of coal gas retorts heated by a regenerative furnace. What is to be done in order that the bench may, with safety, be cooled down and kept idle until the increasing demand for gas, or other reason, shall make it important to again fire it up? No repairs are to be made to the bench.

3. Describe one or more forms of steam, hydraulic, compressed air or electric machines for charging retorts.

4. Give a description, illustrated with sketches, of a full set of retort house firing and cleaning tools. Do not include in your answer tools for repairing, or coal and coke wagons.

5. Describe the cleaning of a water gas washbox, including the precautions to be observed.

6. Describe the testing or proving of a station meter, giving each step of the work from the putting it out of use in order to test it, to the putting it to work again after it has been tested.

7. A station meter passed a volume of gas at a temperature of 69° F. and registered 1,050 cubic feet; what would the same gas measure if its temperature were reduced to the standard—60° F.? Give your calculations.

8. A certain illuminating gas has a net heating power of 620 heat units per cubic foot. It is desired to bring to a temperature of 140° F. two gallons of water placed in a pot and over a burner which together will put into the water 28% of the heating power of the gas. The water at the start has a temperature of 55° F. The barometer marks 30 in. atmospheric pressure. How much gas must be burned to produce the desired result?

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9. Five pounds of ammonia gas (NH_3) are produced by, and collected in the ammoniacal liquor resulting from, the carbonization of a net ton of coal and this liquor is used for the manufacture of sulphate of ammonia with a loss of 5% in the process of manufacture. How much dry sulphate of ammonia will it yield, and how much pure sulphuric acid will be used in the operation, assuming no waste of acid? Give your calculations.

10. Describe the painting of a gas holder, giving each detail of the work, and including the preparation of the iron by the removal of old paint and rust.

11. What is napthalene? What are its physical properties, and how are the obstructions caused by it removed?

12. What is meant by the statement, "The tank was rendered with neat cement"? What circumstances call for the rendering with cement of a brick tank for a gas-holder?

(Answers to these questions are due October 1, 1906.)

ANSWERS TO SEVENTH SERIES OF QUESTIONS—SECTION OF 1908 PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

Answers to questions Nos. 1, 2 and 5 have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 1, Vol. I., page 82.

No. 2, Vol. I., page 242.

No. 5, Vol. I., page 85.

The answers to the other questions are as follows:

3. Describe one or more forms of steam, hydraulic, compressed air or electric machines for charging retorts.

Ans. The Bronder machine is one worked by steam. It consists of a carriage or platform mounted on wheels, running on a track laid on the charging floor of the retort house, in front of, and parallel to, the face of the retort stack. This

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platform carries a steam boiler, a coal hopper, a track at right angles to the main track, upon which run the wheels of a second carriage called the scoop carriage, and two steam engines, one for the purpose of moving the main carriage back and forth along the track on the floor, and the other for moving the scoop carriage, and the scoops attached to it, back and forth in a direction at right angles with the front of the stack.

Motion is communicated to the main carriage by means of an endless screw on the shaft of the engine, and a worm gear on one of the axles of the carriage. The engine is provided with reversing gear and also with a brake on its shaft for the purpose of slowing down and stopping the carriage.

The scoop carriage is driven by a chain or wire rope running around, and driven by, a drum mounted on the main carriage. After winding round the drum, one end of the rope is led to and around a pulley fixed at the front of the main carriage, and then brought back and fastened to the scoop carriage. The other end of the rope is similarly treated, except that the pulley around which it is led is fastened to the back of the main carriage. The drum itself is driven by the corresponding engine through an endless screw and worm gear. The engine is fitted with a reversing gear to which a tappet bar is connected, so that the engine is automatically stopped when the scoop carriage reaches the end of its travel in either direction.

The scoop carriage is provided with shelves or brackets for supporting the scoops, there being one for each scoop. There are usually three scoops arranged vertically, one over the other, at such a distance apart that each comes opposite the corresponding retort in the setting. Under each of the scoop supports are fixed two rollers, the tops of which protrude through openings in the supports, so that the bottom of the scoop rests upon them. Each scoop consists of a long box, or trough, built of steel and open at the top and front end. Resting loosely in the scoop and on its upper edges is a frame with angle iron sides and cross braces, which carries a series of scrapers. All of these scrapers, except the one nearest the back end of the scoop, are so fastened to the frame by pivots

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that their lower edges will swing forward and upward so as to allow them to pass freely over any coal in the scoop or retort when being drawn backward, while they strike and rest firmly against the bottom of the scoop when being pushed forward. The rear scraper is rigid and forms the back end of the coal space in the scoop.

The scraper frame can be moved back and forth relatively to the scoop through a distance a little longer than that part of the scoop which contains the charge of coal. As the scoop with the coal is being pushed into the retort, and just before it reaches the limit of its travel, the lower end of a lever pivoted on the side of the scoop near the back strikes a stop fixed on the coal hopper, and is pushed backward as the scoop moves on. As its fulcrum on the scoop is moving forward the upper end of the lever is given a forward motion, more rapid than that of the scoop, and since it rests against the back of the scraper frame this is pushed forward faster than the scoop, and the scrapers push the coal ahead of them and partly out of the scoop into the seat of the retort, this action taking place just before the scoop stops on reaching the end of its travel. When the scraper frame arrives at its extreme forward position a pawl, pivoted on the main carriage, drops behind the rear crossbars of the frame, and this with the scrapers is thus held stationary, while the scoop is being withdrawn from the retort. By this means the coal is held in place and drops on to the bottom of the retort as the scoop recedes, instead of being drawn backward with it. When the scoop has been entirely withdrawn from the retort, a trip piece on its side strikes an angular tappet piece so pivoted that as its lower end is moved back by the trip piece, its upper end raises the pawl and leaves the scraper frame free to move back. The mechanism which imparts the backward motion to the frame is contained in the back part of the scoop behind the coal space, and consists of a bar, a forward pulley fastened to the scraper frame, a rear pulley fastened to the scoop, and a rope which is fastened at one end to the rear of the scoop, passes forward around the pulley on the frame, back around the pulley fixed to the scoop and forward to have the other

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end fastened to the bar. This bar is free to slide back and forth in guides in the scoop. So long as the scoop and scrapers are traveling together this mechanism travels as a whole with them. When the scoop moves back, while the scraper frame is held stationary, the end of the rope fastened to the scoop, and the pulley also fastened to the scoop, moves away from the pulley fastened to the frame.

To accommodate this motion, that portion of the rope passing around the pulley fixed to the frame must lengthen on each side of the pulley by an amount equal to the distance traveled by the scoop. This extra length can only be obtained by drawing on that part of the rope passing forward from the rear pulley on the scoop and fastened to the bar, which, since the bar is free to move, is practically a free end. The bar, therefore, is given a backward motion (in the same direction as the scoop) twice as fast as that of the scoop. This continues until the detaining pawl has been lifted, as described above. The continued movement of the scoop then immediately brings the end of the bar against a stop fastened on the main carriage, against which the rear end of the scoop also rests when it is at the extreme back end of its travel. The motion of the scoop still continues, but that of the bar being arrested, the end of the rope fastened to it is no longer a free end, and as the scoop moves back the rope is thus held at one end, while the other end, which is attached to the scoop, is drawn backward, as is also the loop passing around the pulley fastened to the scoop. The only part that is free to move to furnish the slack required to accommodate this double motion is the pulley fixed to the scraper frame, and this is accordingly drawn back, bringing with it the frame and scrapers at a rate of motion twice as fast as that of the scoop. The mechanism is so adjusted that when the scoop stops at the end of its travel the scrapers have reached their original position and everything is ready for another charge.

Both the scoop and the scraper frame are weighted at the rear end, the weight on the scoop serving to indicate when the proper weight of coal for the charge has been run into the scoop, and that on the frame acting as a counterweight to

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balance the portion which is left projecting into the retort as the scoop is withdrawn.

Either one, two or all three of the scoops can be locked either to the scoop carriage or to the main carriage. The scoops which are locked to the main carriage remain stationary when the others are run into the retorts, and in this case the rollers fixed to the scoop carriage, and on which the scoops rest, come into play to reduce the friction between the stationary scoop and the moving carriage.

The boiler and engines do not require any detailed description.

The coal hopper is divided into three equal compartments, each having a longitudinal opening the full length of the coal space of the scoop, and in such a position vertically as to allow the coal to be fed through it by a feeding device into the corresponding scoop. It is intended that it should be made large enough to hold all the coal required for the retorts to be charged at any one time.

The operation of the machine is as follows:

Two attendants are required; one to handle the traversing engine and the other to attend to the actual charging. When the machine is placed in front of the proper retorts the scoops are filled until the weight of the coal causes the front part to just balance the weight at the rear end, the forward rollers of the two under each scoop acting as fulcrums. The scoop carriage engine is then started forward and the motion of the carriage carries the scoops attached to it into the retorts. Just before this forward motion is automatically arrested, when the front ends of the scoops have reached nearly to the back ends of the retorts, the accelerated forward motion is imparted to the scrapers so that the coal is pushed into the seat of the retort. As the engine stops and the carriage is brought to rest, the detaining pawls drop and hold the scraper frames. The engine which has stopped automatically, is then reversed by the attendant and the scoops withdrawn from the retorts, leaving the coal, which is held in place by the scrapers. The front ends of the scoops being lightened by the removal of the coal, are raised by the lowering of the counterbalance weights

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at the rear end and carry with them the scraper frame, raising the scrapers nearly clear of the coal. The continued backward travel of the scoops raises the detaining pawls, brings the bar of the scraper-withdrawing mechanism against the stop and then withdraws the scrapers, the engine being stopped automatically when everything is in its original condition at the back end of the travel of the scoop carriage. The main carriage is then moved opposite the next tier of retorts and the operation repeated, the process being continued until all the retorts have been charged.

West's charging machine is driven by either compressed air or electricity, the former being used in the machine described below. In it, as in the other machines described, the charging apparatus proper and a coal hopper are carried by a frame which can be moved along a track laid on the charging floor of the retort house parallel to the front of the bench. The machine has only one charging scoop, so that only one retort can be charged at a time, and this scoop and the coal hopper are so hung in the frame that they can be readily adjusted to the level of the retort to be charged. This adjustment is performed by means of the same compressed air motor by which the machine is propelled back and forth in front of the benches.

Attached to the bottom of the coal hopper is an adjustable measuring chamber to measure out the proper charge of coal. This chamber is made in two parts which telescope into each other and are held, by adjusting bolts, in the position desired with relation to each other, which is determined by the size of the charge. Sliding doors are provided at the top and bottom of this measuring chamber, and the levers actuating these doors are connected together in such a manner that when the doors at the top of the chamber are open, those at the bottom are shut, while the latter cannot be opened until those at the top are shut.

The charging scoop is carried on a frame composed of side bars in which runs the carriage for the gear by which the scoop is turned over, and of rails on which the scoop carriage runs when it is drawn out of the retort into position for filling.

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A movable flap is provided to form a bridge over which the scoop carriage can run between the rails on the machine and the retort. The scoop carriage is propelled into and out of the retort by means of a piston driven back and forth in a cylinder by compressed air. To this piston is attached a rod and rack which engages a pinion attached to the shaft of a chain drum. Around this drum are wound two chains which go out in opposite directions, and after passing, one around a pulley at one end of the frame in which the scoop carriage travels, and the other over another pulley at the other end of the same frame, are both attached to a double chain pulley fastened to the main scoop rod. They are passed around this pulley in such a way that at the proper time the scoop rod can be rotated either in one direction or in the other.

The charger scoop, which is usually made of a length equal to half of that of the retort to be charged, consists of two scoops supported on a carriage which rests on three wheels, two at the back and one just forward of the middle of the centre line between the scoops. The scoops are supported on the carriage by means of a longitudinal centre bar and end plates, the latter supporting the scoop shafts. At the end of the charger which first enters the retort each shaft is carried by a chain, one end of which is attached to the shaft at the point of the circumference which is lowest when the scoop is in position to be filled with coal, the other end being fastened to the fixed end plate. A loose plate carried on the ends of the shafts and free to move inside of the fixed plate closes this end of the scoops so that the coal cannot fall out. At the other end the scoop shafts are carried by a fixed plate and are provided with gear wheels engaging with gears attached to and driven by the rotation of the main shaft.

Each scoop consists of two parts which are capable of sliding concentrically over one another for a determined distance. One of these parts is rigidly connected to the scoop shaft so that it must rotate with this shaft, the other hangs loosely on the shaft and can be rotated around it. When the main shaft is rotated the gears cause the scoop shafts to rotate also. Each of these shafts carries with it the portion

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of the scoop fastened to it. This slides inside of the loosely-hanging portion until its inner edge strikes against stops fastened to the latter. As the shaft continues to turn, the loosely-hanging portion is carried along by the other part until the shaft has completed a half revolution and the folded-together parts of the scoop are completely inverted. During this half revolution the chain from which the loose end of the scoop shaft is suspended has been wound round this shaft and the shaft has been raised so that, when the rotation stops, the inverted scoop is higher than it would have been had it turned about a fixed centre, and it can consequently be drawn out without coming into contact with the coal deposited in the retort. The action described takes place simultaneously with both scoops, each turning in toward the middle of the retort so that the coal is dropped against the sides and into the corners.

The operation of the machine is as follows:

The coal hopper having been filled from an overhead coal bin placed in a convenient position in the retort house the machine is moved along the floor until it is opposite the retorts which are to be charged first. The height of the charger is then adjusted to that of the retort, the movable flap put into the mouthpiece and the measuring chamber filled with coal, which is then run into the scoop. The attendant, by means of a lever which controls the valves, admits to the proper end of the cylinder which drives the charger, compressed air obtained through a hose and hose drum, so arranged that the hose unwinds from the drum as the machine moves away from, and is again wound up as the machine approaches, the drum. The piston being set in motion by the pressure of the air carries with it the rack which rotates the drum, winding up one chain and unwinding the other in such a way that the charger is propelled into the retort. Stops are arranged on the charger carriage frame so that the motion of the carriage will be stopped at the proper points. The piston continues to move after the motion of the charger is arrested and the pull on the chain rotates the main shaft, which causes the scoops to be rotated in their turn in the manner described above and the

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coal is deposited on the bottom of the retort. The double chain pulley, by which the main shaft is rotated, being prevented from turning by pawls which are released when the pulley carriage comes against the stops by which the motion of the charger is arrested, this turning cannot take place until the scoop has reached the proper point in the retort.

The coal having been deposited in the retort, compressed air is admitted to the other end of the cylinder and the piston driven in the reverse direction. The charger is held in place by a pawl, so that the first effect of the reversal is to rotate the main shaft in the other direction and so rotate the scoops back to their original position. When this has been done a projection on the side of the double pulley comes in contact with the pawl holding the pulley carriage, raises it and allows the charger to be withdrawn as the movement of the piston continues.

The operation is then repeated, bringing into play an intermediate stop which arrests the travel of the charger at the proper point to deposit the second portion of the charge in the proper position in the front of the retort.

The charger is then adjusted to the level of the next retort and the operations continued until all the retorts in a vertical tier have been charged. The machine is then moved along to the next tier of retorts to be charged and the series of operations repeated until the whole number of retorts to be handled at one time have been charged.

The West machine has been developed in England, and it is only within the last few years that any examples of it have been erected in this country. A detailed description of it, fully illustrated, will be found at page 335 of Vol. LXXVII. of the Journal of Gas Lighting, etc.

The De Brouwer machine is driven by electricity. It differs from the machines already described in that no part of the machine itself enters the retort, the coal being projected into the retort by the velocity imparted to it by means of an endless belt. The machine is a very simple one. A frame, which can be either mounted on wheels running on rails set in the floor or suspended from wheels running on

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overhead rails, carries a small coal hopper, a system of pulleys over which runs an endless belt and an electric motor by which motion is imparted to the driving pulley of the series. The belt is carried one-quarter around a large grooved wheel, the belt being about 13 in. wide and the groove in the wheel 6½ in. wide and 4 in. deep. The belt, when it leaves this wheel, is traveling in a horizontal direction and continues so for a foot, when it turns downward over one of the small pulleys. It is then led back horizontally to a pulley which keeps it clear of the upper part and from there is led vertically up to and over the pulley which again brings it in contact with the large grooved wheel. The belt having been set in rapid motion by the motor-driven pulley, the coal is dropped from the hopper into the space enclosed between the belt and the grooved wheel, and is carried by the belt around the wheel and projected horizontally into the retort. The speed at which the belt travels is regulated to suit the distance to which the coal has to be thrown in order to reach the back of the retort, the longer the retort the higher being the speed employed. The coal, when it leaves the belt, possesses sufficient velocity to carry it to the back of the retort, and the first pieces of coal being stopped there the rest gradually fills the retort with an even layer from back to front.

This is one of the most recent inventions in the line of charging machinery, but examples of it are already in operation in America.

More detailed descriptions of this machine will be found in the Journal of Gas Lighting, etc., Vol. LXXXII, page 367 and 523. (Trustees.)

4. Give a description, illustrated with sketches, of a full set of retort house firing and cleaning tools. Do not include in your answer tools for repairing, or coal and coke wagons.

Ans.

FURNACE TOOLS.

SECONDARY BARS: Made of 2½-inch x ⅝-inch refined iron, welded to a piece of 1⅛-inch round iron, with a 2-inch head for driving with a sledge hammer.

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These bars are driven through the fire above the clinker line, and hold up the fuel while the ashes and clinker are removed from the lower part of the furnace.

CLEANING RAKE FOR PRIMARY AIR PORTS INTO FURNACE: Made of ½-inch round iron, with an eye handle and a small rake end at right angles to main portion of handle. One right and one left for the two sides of the furnace.

Used for raking out the ashes that get into the air ports during the cleaning of the fire.

STOKING RAKE: Made of a piece of 3-inch x ¾-inch flat iron, 5 inches long, welded in centre at right angles to a round rod, tapering from 1⅛-inches where welded to the flat iron to ⅞-inch at the eye handle, and 10 feet 6 inches long over all.

Used to push the coke well to the back of the furnace, immediately before and during the stoking draw, to secure an even fuel bed throughout the whole depth of the furnace.

FURNACE CHUTE: Made of No. 11 B. W. G. iron, bent to proper shape, bound with ¼-inch x 1¼-inch flat iron, and provided with legs of ½-inch x 1½-inch flat iron.

It is used to catch the coke as it is drawn from the top and middle retorts on one side of a bench of sixes and causes it to slide in the charging opening of the furnace into which the lower part of the chute fits, the stoking rake being used to push the coke into the back of the furnace from this opening.

RETORT TOOLS.

DRAWING RAKE: Head made of ¾-inch x 3-inch flat iron, 13 inches long, welded to handle at a point 1½ inches from the end. Handle 1¼-inch round iron, for 18 inches from head, 1-inch round for 8 feet more, and ⅞-inch round for the rest of the 14 feet 6 inches length. Eye on end of handle.

Used for drawing the coke out of retorts.

CARRYING STICK: Made of ⅞-inch round machine steel, 3 feet 6 inches long over all, and with proper curve in middle to fit the bottom of the scoop.

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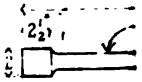

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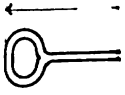

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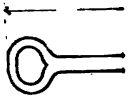

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Used for lifting and carrying front end of scoop when charging the retorts.

SCOOPS: Made of No. 14 B. W. G. soft steel, cut to size sheets needed (15 inches x 105 inches), and pressed into shape in a press made of three 6-inch pipes, with necessary screw arrangements. Reinforced for 16 inches at the head with a piece taken from an old scoop. Strip of ⅜-inch x 1¼-inch iron riveted along outside at bottom to stiffen it. Head made of ½-inch soft steel, bent to proper shape on anvil, with a strengthening piece of ¾-inch steel put on around opening for handle. Handle 1½-inch round steel, upset on inside, and welded outside to a piece of round iron of same size tapering to ⅞-inch in two feet. Cross-bar of handle ⅞-inch round, and 2 feet over all.

Used for charging coal into retorts.

"TIPPLER": Made of ⅞-inch round iron, with eye handle and short hook on other end tapered down to ⅝-inch at point.

Used on charging floor for slacking off levers, opening lids of mouth-pieces, raising the flaps covering the openings through the floor into cellar, and every other purpose requiring the use of a hook.

LEVELING RAKE: Made of a piece of ¾-inch x 3½-inch flat iron, cut to a semi-circle of 7 inches in diameter, welded at right angles to a handle 6 feet long, the first 12 inches of which is 1-inch round iron and the rest ¾-inch round, with an eye on end.

Used for leveling back the coal from the mouth-piece into retort after the charge, also for closing the lid and pushing in the lever.

MOUTH-PIECE BAR: Made of ⅝-inch round iron, with eye handle and a chisel end of steel, pressed to an edge and tempered, 4 feet long.

Used to chip off the tar and pitch that accumulate on inside of mouth-piece lids.

BUCK: Made of two 1-inch Ells, with side outlets, and the necessary 1-inch pipe to form four legs and a cross-piece.

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Used to support the drawing-rake and raise it above the bottom of the retort when drawing the bottom retorts, thus saving the fireman from so much stooping in handling the rake on these retorts.

Stand-pipe Tools.

Cutter Head: Forged from 2-inch x 2-inch iron, slotted and drilled, as shown in drawing; for the reception and fastening of cutting tool, and welded to a piece of 1-inch pipe of sufficient length to allow the cutter to reach well into the bend of the stand-pipes from the bottom retorts. Provided with an eye handle parallel to slot in head, so that the direction of the cutter is always known. One of these heads is also welded to a curved handle of ⅝-inch and ¾-inch round iron, similar to the auger handles. The cutting tools for use in these heads are made of ⅝-inch by 2½-inch steel, tempered on edges of the slope shown on drawing, in sizes increasing by ½-inch from 4 inches up to 5½-inches in extreme width.

This tool is for use in case the carbon in a pipe is too hard to be cut away with other tools. By its use vertical grooves are cut in the carbon, as shown on the drawing, almost out to the iron. Then the pipe is fired hard for an hour or so—that is, the flame from wood burnt in the retort is drawn up through the pipe, causing the carbon to crack away from the iron, so that it can be broken off in great lumps by means of the "Star," thus cleaning the pipe quickly, even when badly stopped, owing to previous imperfect cleaning. The whole operation can be performed without the excessive jarring and consequent loosening of joints that is necessary in doing the same work with an auger, with the further advantage that stand-pipes that cannot be cleaned with an auger are amenable to this treatment.

Star: Made from a piece of ½-inch steel plate, cut to a circle of the proper diameter, the teeth then being cut out, as shown, and tempered. It is not necessary to make this double, though it is shown so on the drawing. This is fastened to the handle of 1-inch pipe, the length of which is determined

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by that of the longest stand-pipe. In two sizes for use from the top of pipes; also one provided with an auger handle for use from the charging floor.

This tool is used as the first and only tool in cleaning pipes from hard stoppages that are not bad, and to follow the cutter in the case of pipes in which the carbon has been allowed to grow thick. The largest size is of such a diameter that when it has cut its way down a pipe the ring will follow easily.

RING: Made of ⅜-inch x 2½-inch steel, drawn to an edge, as shown on drawing. To it are riveted four ⅝-inch rods, welded together at their other ends, the single rod thus formed being welded to a piece of ¾-inch pipe, long enough to allow the ring to drop to the bottom of the longest stand-pipe.

This ring is used merely to detect the presence of any lumps that the "Star" may have slipped by, and is not used to cut away obstructions of any size. It is made from ¼-inch to ⅜-inch less in diameter than the pipes on which it is to be used.

AUGERS: Made from steel blanks $^{3}/_{16}$-inch thick, and of shape and size shown on drawing. Welded to rods 11 feet long, 7 feet at handle end of which is ¾-inch, and the rest ⅝-inch, round iron. These rods have eye handles and are curved, as shown. The auger heads are given at least one full turn, and preferably more. The augers are used to clean the lower portion of the stand-pipe at each draw. Similar heads are fixed on pipe handles for use in cleaning the pipe from above in case of a lamp-black or other soft stoppage.

BASKET: It sometimes happens that a pipe is allowed to run so long, or is so handled when the cleaning is begun, that it becomes completely choked up with carbon so hard that it is almost impossible to drive even a pointed bar through it. It is for such cases that this basket is useful. It is made of a piece of perforated iron, cut from a sheet discarded from a rotary coke screen; is open on one side where it abuts against the front wall of the stack, and the bottom has an opening cut far enough back to take in the stand-pipe. A

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pair of tongs with clamping ring, clutches the stand-pipe and supports the basket at the proper height.

Its use is as follows: In the case described above, the obstruction is located and the point marked on the outside of the pipe. The tongs are then clamped on at the right place, the basket hoisted up and placed upon them, encircling the pipes and touching the front wall of the stack. A wood fire is started in the basket and kept up until the heat softens the obstruction sufficiently to allow a fair-sized opening to be made through it, when it is permitted to die out and the pipe burnt clean in the regular way.

NOTE.—The dimensions given on drawings are for tools to be used in 6-inch stand-pipes and retorts 9 feet long. The necessary changes would have to be made in other cases. (Trustees.)

6. Describe the testing or proving of a station meter, giving each step of the work from the putting it out of use in order to test it, to the putting it to work again after it has been tested.

Ans. The meter room should be thoroughly ventilated throughout the test.

The object of testing a station meter is to determine:

A—Whether there are any leaks in the drum.

B—If there are no leaks, how many cubic feet of gas are passed for one revolution of the drum.

C—Whether the index registers correctly the number of cubic feet passed through the drum.

Before the meter is put out of use for the purpose of testing it, remove the plate over the dial, thus exposing the spindle that comes through the meter head, stop the meter long enough to attach a pointer to the spindle and make a mark on the case, so that the exact revolutions of the pointer can be counted. Then start the meter and note how much gas is registered on the index for ten to twenty revolutions of the spindle. Calculate from this the number of cubic feet regis-

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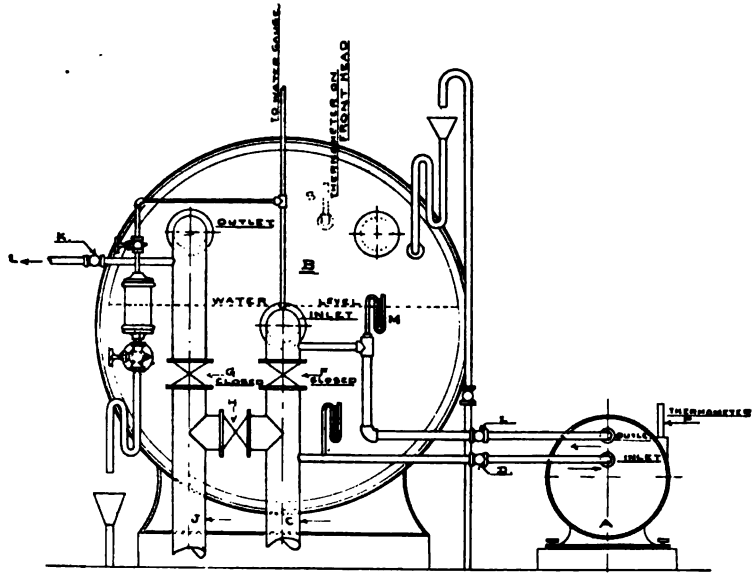
tered for each revolution of the spindle. The use to be made of this figure will be explained later on.

Put the meter out of use by opening the by-pass and closing valves F and G. Pour water into the connections C and J above these valves, to seal the valves. Pet-cocks should be tapped into these pipes above the valves and below the

CONNECTIONS FOR PROVING STATION METER



surface of the water, and opened from time to time during the test, to see that these valves remain sealed.

Now the meter is out of use and ready to be tested.

A—Does the drum leak?

Connect the test meter and iron pipes as shown, and run the pipe L out of doors.

Test the connections of the test meter by opening the cocks D and E and passing a little gas through both meters. Then close the cock K. When the full pressure of the gas shows

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on both meters, if the index of the test meter remains stationary, the outlet connections and the station meter case and gas connections above valves F and G are gas tight.

Close cocks D and E. Remove gauge M, and open cock K, and having thus put atmospheric pressure on both inside and outside of the station meter drum, see that the water in the meter is exactly to the mark on the water gauge and dripping from the automatic overflow, if the meter has this attachment, at the rate that is maintained when the meter is in regular use. Then close K and replace gauge; shut off automatic overflow and close off water supply. Remove the manhole plates on top of station meter; remove one of the plugs in the drum and replace it with a special plug fitted with an eye-bolt, attach a rope to the eye-bolt and make the rope fast to prevent the drum turning. Open cock E, then open cock D slowly, thus admitting gas gradually into the station meter drum until the pressure has increased sufficiently to blow the seals in the meter. The noise of the blowing gas can be heard and the pressure will fluctuate violently. The blowing pressure should be recorded. Now shut D and watch gauge M; if the pressure falls, that section of the drum that is being tested leaks. The size of the leak can be determined by partly opening D, keeping pressure on M below the pressure at which the seals blow and noting the registration of the test meter for, say, ten minutes. Now leave D open and slack the rope until the meter drum has made about one-eighth of a revolution, and repeat the test made above. Repeat this process until the drum has been tested for blowing pressure and for tightness in eight positions. The drum should then have made one revolution.

If the manhole is not available for this test, the spare outlet flange can be removed and the drum blocked in different positions by a piece of scantling.

Before starting to revolve the drum, the position of pointer on spindle on meter front should be accurately marked, and note should be made of the number of revolutions made by the pointer for one revolution of the drum; this is usually exactly one, or exactly two.

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If the drum leaks it must be repaired before test for capacity can be made.

If the drum is tight, proceed to determine:

B—How many cubic feet of gas are passed by one revolution of the drum?

Remove the rope, replace plug and manhole, open automatic overflow and water supply pipe. Repeat test for tightness of connections and case.

Open cock K, and adjust the cock D on the test meter inlet until the gas passes at a rate within the limit of the test meter. Then wait until water begins to drip from the automatic overflow.

The gas now passing through both meters, one observer should call out at the instant the pointer on the station meter spindle reaches the mark on the case, and a second observer should, at the same instant, note and record the test meter reading. When the drum has made one complete revolution as indicated by the pointer, note and record the test meter reading as before. The quantity thus registered by the test meter is the quantity of gas passed by one revolution of the station meter drum. To insure accuracy, at least three revolutions of the drum should be made.

During this test the temperature of the water in the two meters should be as nearly as possible the same as the temperature of the room.

C—Does the index register correctly the number of cubic feet passed through the drum?

Count the teeth on the gear wheels connecting the spindle with the meter index and calculate the number of cubic feet registered by one revolution of the meter drum. This figure should agree closely with that obtained at the outset, by calculating from the registration of the meter during twenty revolutions. This latter figure was obtained for the purpose of checking the calculations from the gear wheels. Accept the figure obtained by counting the teeth on the gear wheels as correct.

If the figures obtained by tests B and C are the same, the meter is correct; if the quantity passed (B) is greater than

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the quantity registered (C), the meter is slow; if the contrary, the meter is fast. If the meter is not correct, it is better to change the gears, leaving the water level at the position marked. If inconvenient to have gears changed, alter water line to correct, raising it if meter is slow and lowering if meter is fast, and test again. Only very small errors can be corrected for by this method, and it should be used only on small meters.

To put the meter in use again, remove the test meter connections and pipe L, remove the pointer from spindle and replace dial plate, open valves F and G, and close valve H.

NOTE.—Test meter is preferably a 60 or 80-light wet meter, with a dial registering to one-tenth of a cubic foot. This meter should be carefully tested on a meter prover when passing gas at the same rate as during the station meter test. This can be readily done by maintaining the same difference of pressure between inlet and outlet of test meter, as observed during test B.

The test meter should always be set level.

NOTE.—Test A can be made without a test meter, using a pressure gauge only. A common, dry meter can be used to measure the leakage.

NOTE.—If the temperatures of the gas passing through the test meter and through the station meter are different, the volume of the gas passing through the test meter should be corrected to the temperature of the gas passing through the station meter. This can be done by the use of a table for the correction of the volumes of gas at different temperatures.

NOTE.—If the meter drum leaks have it repaired. Do not attempt to correct for leaks in drum by raising water line.

The above is an accurate and scientific, if somewhat difficult, method of proving a station meter. A more simple method is as follows:

To prove the tightness of the drum: Proceed as above down to and including the determination of the tightness of case and connections, and the correctness of the water line. Then run gas through both meters at a rate about equal to the maximum capacity of the test meter, and again at half that rate,

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making the test cover in each case an equal number of and at least three full revolutions of the drum of the station meter. If the tests agree the drum is tight.

This method does not necessitate opening the manhole of the meter.

Determine the capacity of the drum per revolution as above.

Count the teeth on the gear wheels as above and calculate the number of feet registered by one revolution. If you do not understand the gear wheel and dial combination, test for drum tightness and capacity as above, disconnect test meter and turn gas through the station meter as if in regular use for twenty revolutions of the drum, as shown on the pointer. See if the dial registers twenty times the determined capacity of the drum. If it does, the meter registers correctly. (Trustees.)

7. A station meter passed a volume of gas at a temperature of 69° F. and registered 1,050 cubic feet; what would the same gas measure if its temperature were reduced to the standard—60° F.? Give your calculations.

Ans. The volume occupied by a certain weight of a dry and perfect gas varies with the pressure and the temperature to which the gas is subjected. When the gas is saturated with moisture, as is the case with illuminating gas when measured in a station meter, the tension or pressure of the water vapor contained in it must also be considered.

The rules for the effect of pressure and temperature on the volume are that the volume varies inversely as the pressure, and that it increases or decreases by $^1/_{492}$ of the volume of the gas at 32° F. for each increase or decrease in temperature of 1° F. As the pressure remains constant in the case of which the question treats, the temperature only will have to be considered, and if the gas were dry the change in volume could be calculated as follows:

Since the gas increases in volume $^1/_{492}$ of its volume at 32° F., for each increase in temperature of 1° F., 492 parts of 32° would become

$492 + (60 - 32) = 492 + 28 = 520$ parts at 60° F., and

$492 + (69 - 32) = 492 + 37 = 529$ parts at 69° F.

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Therefore, the volume at 69° F. would be to the volume at 60° F. as 529 is to 520, and substituting the values for the present problem the proportion becomes,

$$1050 : x : : 529 : 520 \text{ or } 529\,x = 546{,}000, \text{ and } x = 1032$$

Therefore, 1050 cu. ft. measured at 69° F. would only be 1032 cu. ft. if measured under the same pressure and at 60° F.

But as the gas is necessarily saturated with water vapor, since it is in contact with water, the effect of this water vapor, which does not expand under the influence of temperature and pressure according to the laws governing the expansion of gases, must be taken into account. To do this a formula is used which includes the effect of both pressure and temperature. A temperature of 60° F. and a pressure of 30 in. of mercury are taken as the standard conditions under which the volume is to be measured, or to which volumes measured under other conditions are to be corrected.

Representing the volume at 60° F. and 30 in. pressure by V and that of the same mass of gas at any other temperature t and any other pressure h, by v, we can, from the laws given above, derive the required formula for dry gases. Since the volume varies inversely as the pressure, the product obtained by multiplying the volume at any pressure by that pressure is equal to the product obtained by multiplying the volume of the same mass of gas at any other pressure by the corresponding pressure and we have,

$$30\,V = h\,v \text{ or } V = \frac{h}{30}\,v.$$

The effect of temperature as given above is shown by the equation $V\,(460 + t) = 520\,v$, since t is the number of degrees above 0 and therefore $460 + t$ is equal to 492, the number of parts at 32° F., plus one volume for each degree increase in temperature above 32° F., while 520 is the number of parts to which 492 parts at 32° will have expanded when the temperature is raised to 60°. From this we obtain the equation,

$$V = \frac{520\,v}{460 + t}.$$

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Combining these two equations we have for dry gases

$$V = \frac{v \times h \times 520}{30\,(460 + t)},$$

that is, the volume corrected to the standard condition of 60° F. and a pressure of 30 in. of mercury is equal to the observed volume multiplied by the observed pressure in inches of mercury multiplied by 520 and divided by 30 times the sum of 460 and the observed temperature.

The correction for moisture depends on the fact that a given volume of gas saturated with water vapor, as will be a gas in contact with and over water, will under the same conditions of temperature and pressure always contain the same quantity of water vapor. This vapor exerts a certain pressure which increases with the temperature, and is proportional to the amount of vapor present. The pressure so exerted has been determined in inches of mercury for each degree of temperature. To correct for the presence of moisture in a gas saturated with vapor, it is necessary to deduct the pressure due to the tension of water vapor from the observed barometric pressure, since this barometric pressure is resisted partly by the pressure of the water vapor and partly by that of the gas, and therefore the pressure exerted on the gas will be really only the difference between the barometric pressure and the pressure due to the tension of the water vapor. Calling this tension of water vapor a, and taking its value at the temperature of 60° (.518) to deduct from the standard barometric pressure of 30 in., we have for the formula for reducing the volume of gas saturated with water vapor observed at any temperature and pressure to that of gas saturated with water vapor at 60° and 30 in.,

$$V = \frac{(h - a) \times 520 \times v}{(30 - .518) \times (460 + t)} = \frac{(h - a) \times 520 \times v}{29.482\,(460 + t)}$$

or dividing both numerator and denominator of the fraction by 29.482

$$V = \frac{17.64\,(h - a)\,v}{460 + t}$$

which may be expressed in words as follows:

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The corrected volume of a gas saturated with water vapor at the standard condition of 60° F. and 30 in. barometric pressure is equal to the observed volume multiplied by 17.64 times the difference between the observed barometric pressure and the tension of water vapor at the observed temperature, and divided by the sum of 460 and the observed temperature in Fahr. degrees. The tension of water vapor for the observed temperature must be found from the table giving the tensions for the different temperatures.

Applying the formula to the present example in which the observed volume $v = 1{,}050$ cu. ft., the observed temperature $t = 69°$, the observed pressure, which is not given, is assumed to be 30 in., thus making the correction one for temperature only and the tension of water vapor at 69°, a, is 0.708, V (corrected volume at 60° =

$$\frac{(30 - 0.708) \times 17.64 \times 1050}{460 + 69} = \frac{29.292 \times 17.64 \times 1050}{529} =$$

$$\frac{542546}{529} = 1025.6 \text{ cu. ft.}$$

The values of the fraction $\frac{17.64\ (h - a)}{460 + t}$ have been calcu-

lated for each $^1/_{10}$ in. of pressure from 28 in. to 31 in., and for each 2° of temperature from 40° to 84°, and the table so formed is given in Newbigging's "Gas Engineers Hand Book' and Hornby's "Gas Engineers' Laboratory Hand Book." From this table the number by which it is necessary to multiply the volume observed at any pressure and temperature in order to obtain the correct volume at 60° and 30 in. can be found. The numbers for the odd numbered degrees can be obtained by interpolation. (Trustees.)

8. A certain illuminating gas has a net heating power of 620 heat units per cubic foot. It is desired to bring to a temperature of 140° F. two gallons of water placed in a pot and over a burner which together will put into the water 28% of the heating power of the gas. The water at the start has a temperature of 55° F. The barometer marks 30 in. atmospheric

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pressure. How much gas must be burned to produce the desired result?

Ans. As the gas has a heating power of 620 heat units per cubic foot and the burner and pot enable 28% of the heat developed by the gas to be imparted to the water, each cubic foot of gas will give to the water $^{28}/_{100} \times 620 = 173.6$ heat units. To raise the temperature of one pound of pure water from 55° F. to 140° F., $140 - 55 = 85$ heat units will be required. The weight of a gallon of water at a temperature of 60° F. is commonly taken as 8.33 lb., and, therefore, two gallons will weigh 16.66 lb. To raise the temperature of this weight from 60° F. to 140° F. there will be required $85 \times 16.66 = 1{,}416$ heat units. Since each cubic foot of gas used supplies 173.6 heat units, there will be required to supply 1,416 heat units $\frac{1{,}416}{173.6} = 8.16$ cubic feet. If all the heat the gas is capable of producing could be imparted to the water there would be required only 2.28 cubic feet. The difference between this amount and that actually required is due to the imperfections of the apparatus. (Trustees.)

9. Five pounds of ammonia gas (NH_3) are produced by, and collected in the ammoniacal liquor resulting from, the carbonization of a net ton of coal, and this liquor is used for the manufacture of sulphate of ammonia with a loss of 5% in the process of manufacture. How much dry sulphate of ammonia will it yield, and how much pure sulphuric acid will be used in the operation, assuming no waste of acid? Give your calculations.

Ans. Since 5% of the ammonia is lost in the process of manufacture, the amount of ammonia converted into sulphate is 95% of 5 pounds, or 4.75 pounds. The formula of sulphate of ammonia is $(NH_4)_2SO_4$ or two molecules of ammonia gas, NH_3, unite with one molecule of sulphuric acid, H_2SO_4. A molecule of ammonia gas being composed of 1 atom of nitrogen and 3 atoms of hydrogen, and the atomic weight of nitrogen being 14, and of hydrogen being 1, the atomic weight of a

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molecule of ammonia gas is—nitrogen, 14, hydrogen, 3, or 17. The atomic weight of 2 molecules is therefore 34. The atomic weight of hydrogen being 1, and of sulphur 32, and of oxygen 16, sulphuric acid, being a combination of 2 atoms of hydrogen, 1 atom of sulphur and 4 atoms of oxygen, has an atomic weight of 98, and the atomic weight of sulphate of ammonia will be $98 + 34 = 132$. Therefore, 34 pounds of ammonia combine with 98 pounds of sulphuric acid to form 132 pounds of sulphate of ammonia, and $^{34}/_{132}$ of sulphate of ammonia, or 25.75%, will be ammonia gas. Since 34 pounds of ammonia, combined with sulphuric acid, will produce 132 pounds of sulphate of ammonia, 4.75 pounds of ammonia gas will, combined with sulphuric acid, form 34 : 132 : : 4.75 : ? or, 18.44 pounds of ammonia sulphate. Of this, 4.75 pounds being formed of ammonia gas, the remainder, or 13.69 pounds, is formed of sulphuric acid. The percentage of ammonia gas in pure sulphate of ammonia is 25.75 by weight. We may, therefore, prove our problem by multiplying 18.44 by .2575, which gives us 4.748, or within .002 of a pound of the 4.75 pounds of ammonia gas with which we started our problem. This slight difference is due to our not having carried the decimals in our divisions further than the second place. (Trustees.)

10. Describe the painting of a gasholder, giving each detail of the work, and including the preparation of the iron by removal of old paint and rust.

Ans. The crown of the holder should be scraped and painted before beginning the work on the sides. Brush over thoroughly with wire brushes, notice the seams and rivets particularly, and brush thoroughly around and between the rivets. Where the old paint is scaly, blistered, or in thick lumps, scrape the surface with chisels or scrapers. Do not let the men skip from one place to another; finish each sheet before beginning another. On the crown begin at the centre and work outward. When the cleaning is done, and when ready to paint, sweep the surface with brooms and apply paint. Work it on as thin as possible, and apply two thin coats in preference to

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a single thick coat. Be sure the first coat is dry before starting the second.

If leaks are found they should be stopped before the painting is begun.

The cleaning of the sides of a holder will depend upon the conditions at the works. If the holder can be put out of use, the cleaning and painting can proceed uninterruptedly. If the holder remains in use the work will proceed as opportunity offers.

In cleaning begin at top row of sheets and work down. If possible, provide a sufficient number of men to do the cleaning as the holder rises. If this is not practicable, arrange your force to cover one-half, or any other fraction of the circumference, at one time.

Provide scrapers, brooms and brushes with short and long handles. Short ladders will also be found convenient at times. There should be no hurrying, and the foreman should inspect and pass upon each sheet as it is cleaned before the workman changes to another sheet. Faults are located more certainly this way than by inspecting at intervals.

Do not paint until the cleaning is finished for the day. Then begin at the top and work down. When the upper sheets are being painted the holder will be nearly grounded. It can be made to rise very slowly, so that by the time any course of sheets is, say, five feet above the water, the surface is thoroughly dry. The paint should be worked well in as it is applied. The paint should not run. Only such sheets as can stay above water three hours at least should be painted. When the bottom sheets are reached, have the holder up in the morning nearly to blowing, and keep it up as long as possible, so that the paint can dry thoroughly. (Trustees.)

11. What is naphthalene? What are its physical properties, and how are the obstructions caused by it removed?

Ans. Naphthalene is a hydrocarbon formed in comparatively small quantity (about 13.15 lb. per ton of ordinary English coal distilled in coal gas retorts, according to Mr. R. W.

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Irwin) during the distillation at high temperatures of carbonaceous substances, such as coal and petroleum. It has been claimed that naphthalene can be formed in the gas after it leaves the retorts and during distribution, but this view is generally held to be incorrect, and from the present knowledge of the subject it seems practically certain that all the naphthalene found either in coal gas or coal tar is produced during the distillation of the coal in the retorts. The molecule of naphthalene is composed of 10 atoms of carbon and 8 atoms of hydrogen, its chemical symbol being $C_{10}H_8$.

It is a solid at ordinary temperatures and pressures, melts at a temperature of 176° F. and boils at about 430° F. It will, however, exist in a state of vapor suspended in gas at temperatures far below even that at which it solidifies as long as the gas is not saturated with it. As soon as the point of saturation is reached the vapor passes directly into the solid state in the form of very light, flaky, flat crystals, which occupy a large volume in proportion to their weight. It is this property which renders naphthalene so troublesome to the gas manufacturer, since though the weight contained in a given quantity of gas is small (about .15 lb. per 10,000 cubic feet of ordinary English coal gas, according to Mr. R. W. Irwin) the crystals occupy sufficient space to seriously obstruct the apparatus and pipes around the works and the services in which they are deposited through chilling of the gas.

Naphthalene obstructions in the apparatus and pipes at the works are usually removed either by flushing with hot water or by steaming, the former being preferable, since the steam merely melts the naphthalene, and unless it can escape from the pipe at once it may cool down again and solidify in another part of the apparatus, while the hot water acts not only by melting the naphthalene but also by carrying it along, to a certain extent, in mechanical suspension. It is well to use the water in considerable volume in order to secure this latter effect.

Naphthalene is removed from service pipes and small mains by means of light naphtha, gasolene or kerosene, which is poured into and allowed to run through the pipes, dissolving

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the crystals and carrying the naphthalene in a liquid form back into the mains and the drips. Sometimes wood alcohol is used instead of naphtha or kerosene. If the obstruction is very light it may be blown out of the service into the main by means of an air pump, or even by the lungs.

Naphthalene in the form of crystals, like water in the form of ice or snow, will pass from the solid state directly into that of vapor, and thus naphthalene that has been deposited in the pipes in quantities too small to cause trouble and render it necessary to clean it away will evaporate again and pass off with the gas when this reaches the deposit in an unsaturated condition. This same naphthalene may be redeposited farther along in the system if the temperature changes so as to bring the gas again to the point of saturation with naphthalene, and it is probable that some action of this kind has given rise to the theory that naphthalene can be formed during distribution in a gas which was free from it when it left the holders. (Trustees.)

12. What is meant by the statement, "The tank was rendered with neat cement?" What circumstances call for the rendering with cement of a brick tank for a gasholder?

Ans. To "render" a wall is to plaster directly upon the wall, without the use of lathing. Technically it is to apply one coat.

"Neat cement" means cement unmixed, free from adulteration. Therefore, the statement, "The tank was rendered with neat cement" means that the wall and bottom were covered with one coat of a mixture of cement and water, without sand, applied directly to the face of the masonry.

A brick tank for a gasholder would be rendered with cement to make it watertight when the local conditions were such as to cause to be excessive, the cost of securing this tightness by means of a backing of clay puddle put immediately outside the wall as well as under the foundations and the bottom of the tank. If not too expensive, the use of clay puddle is preferable to rendering with cement, because when a

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holder-tank is made tight by puddle the contained water soaks through the brickwork and exerts its pressure upon the backing and not upon the wall, as it does when the wall is rendered on the inside, and the wall being relieved of the pressure is not so apt to crack. (Trustees.)

ELEVENTH SERIES OF QUESTIONS—SECTION OF 1907—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Give your theory of the causes of stoppages in the standpipes of coal gas retorts, and the means you would employ to prevent them.

2. Describe the painting of a gas holder, giving each detail of the work, and including the preparation of the iron by removal of old paint and rust.

3. Give a description, illustrated with sketches, of some form of steam jet that will give good results when applied to keep the water in the tanks or the cups of gas holders free from ice.

4. If you had to install a new boiler plant, what general considerations would influence your choice of type of boiler to be used?

5. In the manufacture of carburetted water gas it is found that with the use of ordinary methods of condensing and tar extracting, some vapors remain in the gas until the purifiers are reached and are then deposited in the purifying material with the effect of shortening its life. What has been found to be an efficient way of removing these vapors before the purifiers are reached?

6. How would you calculate the strain that the straps used to hold down the cover of a purifying box will be called upon to resist? Illustrate your answer by working out an example.

7. What effect does the saturation of a gas with one vapor have upon the amount of other vapors that can be carried by the gas?

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8. What is meant by "The Mechanical Equivalent of Heat," and what is its value expressed in foot pounds per heat unit (British Thermal Unit)?

9. Describe a system of Meter Records by means of which full information in regard to each meter owned by a gas company can be filed so as to be available for ready reference.

10. What is the so-called "Otto cycle" in gas engines?

11. With gas selling at $1.25 per 1,000 cubic feet and electric current at 10c. per kilowatt, what are the comparative costs of one candle-power per hour furnished by an incandescent gas light and an incandescent electric light respectively, the cost of renewals being left out in each case?

12. What is re-inforced concrete? Describe the method employed in building it up and state some of the purposes for which it is suitable.

(Answers to these questions are due November 1, 1906.)

Answers to Eleventh Series of Questions—Section of 1907—Practical Class—Trustees Gas Educational Fund.

The answer to question No. 2 is included among the answers to the seventh series of questions for the section of 1908, in this volume. Answers to questions Nos. 1 and 5 have been published in the previous volume of the Proceedings. These answers can be found as follows:

No. 1, Vol. I., page 112.

No. 2, Vol. II., page 82.

No. 5, Vol. I., page 179.

The answers to the other questions are as follows:

3. Give a description, illustrated with sketches, of some form of steam jet that will give good results when applied to keep the water in the tanks or the cups of gas holders free from ice.

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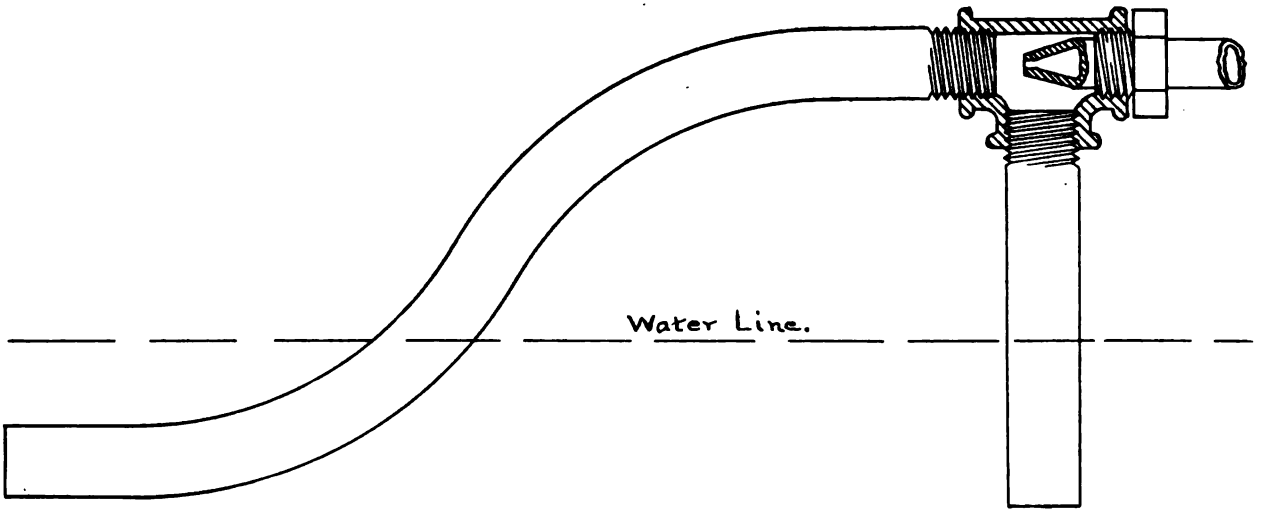

Steam Jet for Holder Tanks and Cups.

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Ans. A very good form of steam jet that can be made from ordinary pipe and fittings is illustrated on the cut. The only fittings needed are a 1-in. tee and a ¾-in. x 1-in. or a ½-in. x 1-in. bushing. Into one of the openings on the run is screwed either a ¾-in. or ½-in. steam pipe, with its end drawn down to a jet opening not more than ⅛-in. in diameter. When screwed into the tee, the end of this steam pipe should project a little past the centre of the tee. A piece of 1-in. pipe about 18 in. long and offset about 6 in. is screwed into the other outlet on the run. Another piece of 1-in. pipe, from 6 in. to 8 in. long, is screwed into the side outlet. When placed in position for work, the tee is set just above the water line in the holder tank or cup, with its run horizontal and the side outlet looking down. The open end of the nipple in this outlet and that of the offset piece are both below the surface of the water. When the steam is turned on, the jet issuing from the orifice creates a vacuum in the side outlet nipple, and the water rises in this nipple and is blown along with the steam through the offset piece. Thus this jet not only heats the water, but also induces a rapid circulation around the tank or cup, as the case may be, and is therefore much more effective than a jet which merely blows the steam into the water, since water will not freeze as quickly when in comparatively rapid motion as it will when almost at rest. (Trustees.)

4. If you had to install a new boiler plant, what general considerations would influence your choice of type of boiler to be used?

Ans. The principal general considerations influencing the choice of type of boiler for any particular installation are, the location and space available; the kind and cost of fuel; the nature of the feed-water; the steam pressure to be carried; the facilities for having repairs made, and the first cost of the boiler and cost of maintenance.

A few applications of these considerations may be indicated.

When the feed-water is such as to cause considerable deposit in the boiler, it is best to choose the simple cylindrical

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form, or a simple flue form, on account of the ease with which these types can be cleaned. The ability to obtain a good fuel at a low cost would also lead to the same choice, owing to saving in interest on first cost more than counterbalancing loss of economy in fuel. Difficulty in having repairs made would also lead to the choice of these types.

With higher prices for fuel and better feed-water, the more complicated flue or tubular boilers are selected on account of greater fuel economy, and under the same circumstances the necessity for such a location of the boiler as would make the results of a possible explosion particularly disastrous, would dictate the selection of one of the so-called "safety" or "sectional" boilers, even though cost and other considerations weighed against its adoption.

The desirability of using a low grade fuel produced on the works, and practically unsalable, might also turn the scale in favor of a special type, not otherwise the most desirable.

Of course, in each case, all conditions, financial as well as engineering, must be carefully considered in making a choice of type. (Trustees.)

6. How would you calculate the strain that the straps used to hold down the cover of a purifying box will be called upon to resist? Illustrate your answer by working out an example.

Ans. The total strain which the holding-down straps on a purifying box cover are called upon to resist is equal to the difference between the lifting force exerted on the cover by the pressure of the gas beneath it and the weight of the cover. The lifting force exerted by the gas, measured in pounds, will be equal to the pressure in pounds per unit of area multiplied by the area upon which the pressure acts. In the case of purifying boxes with water seals, the maximum pressure, in inches of water, that can be exerted on the cover is equal to the depth of the seal and this pressure should be used in calculating the lifting force of the gas. In the case of purifying boxes with covers bolted on, the maximum pressure to which the cover can be subjected will be determined by the depth of

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the seal on the syphons through which the condensation is taken away from the boxes, or the pipes connecting them. To convert pressure in inches of water into pressure in pounds per square foot it is necessary to multiply the former by 5.208, the weight in pounds of a volume of water with an area of one square foot and a depth of one inch.

The strain upon any one strap will depend upon the total strain, the design of the cover and the number of straps. When the cover is flat or when it slopes up equally from all four sides, and the straps are spaced equal distances apart, each strap will bear the same strain, which will be equal to the total strain divided by the number of straps. When, however, as is sometimes the case, the cover is arched in one direction only, practically all the strain is borne by the straps on the two sides from which the rise occurs, very little being transmitted to the ends, and to obtain the strain on each strap the total strain should be divided by the number of straps on these sides only.

As an example of the method of working, the case of a cover for a purifying box 10 ft. square and with a cup 24 in. deep, may be taken. The cover may be assumed as weighing 1,500 lb., as being of such design as to throw the strain on all sides equally and as being held down by eight straps, two on each side. As purifying boxes are designated by the size inside, and the cover fits midway in the cup, which is usually about 6 in. wide, the top of the cover will be 10 ft. 6 in. square and the area on which the gas pressure will act will be 110.25 square feet. As the cover is sealed in water to a depth of 24 in., the pressure under it can never rise above that amount, and the maximum total strain on the straps will therefore be $(110.25\times24\times5.208)-1,500=(110.25\times125)-1,500=12,281$ lb. As there are eight straps the strain on each one will be $\frac{12,281}{8}=1,535$ lb. (Trustees.)

7. What effect does the saturation of a gas with one vapor have upon the amount of other vapors that can be carried by the gas?

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Ans. The effect produced by the saturation of a gas with one vapor upon its power of carrying other vapors depends upon the tension of the vapors in question, and upon the mutual solubility of the liquids from which the vapors are derived. Regnault's experiments prove that "when two liquids exert no solvent action on each other, the tension of the vapors which rise from them is nearly equal to the sum of the tensions of the two separate vapors at the same temperature, while with two liquids that partially dissolve each other, the tension of the mixture is much less than the sum of the tensions, being scarcely equal to that of the vapor with the higher tension; and with liquids that dissolve in all proportions, the tension of the mixture is intermediate between the tensions of the separate vapors." From these laws it is seen that a gas may be saturated with a vapor without any interference with its capacity for carrying the vapors of liquids which are not soluble in each other or in the liquid from which the first vapor is produced, since as these vapors are added to the gas, the tension increases by the amount required to keep them from condensing. If, however, the vapors are from liquids which are soluble in each other, saturation of the gas by any one vapor reduces the capacity for vapors with higher tensions, since the increase in tension due to the addition of the new vapor is not sufficient to make the combined tension as high as would be the tension of the second vapor, if it existed in the gas alone. On the other hand, saturation with a vapor increases the capacity of the gas for vapors of lower tensions as long as the liquids from which the vapors are produced are soluble in each other, since the mean tension of the mixture of the vapors will be higher than that of the vapor of lowest tension, and, therefore, more of this vapor can be carried by the gas. Conversely, the addition of a vapor of very high tension to a gas already saturated with a mixture of vapors of low tension, all the vapors being those of liquids mutually soluble in each other, will slightly increase the capacity of the gas for carrying the low tension vapors, while the addition of a vapor of low tension to a gas saturated with vapors of higher tensions, will decrease the carrying capacity for these higher tension vapors. (Trustees.)

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8. What is meant by "The Mechanical Equivalent of Heat," and what is its value expressed in foot pounds per heat unit (British thermal unit)?

Ans. The "Mechanical Equivalent of Heat" is the amount of mechanical energy which is equivalent to (that is, which when transferred into heat will produce) one heat unit. (Century Dictionary.)

The first accurate determination of the value of this constant quantity was made in 1849 by Joule, who measured the amount of heat produced by the friction of a paddle wheel in a vessel of water, the energy required to turn the paddle being derived from the descent of a known weight through a known distance. He found that to raise the temperature of one pound of water 1° F. required the expenditure of 772 foot pounds of mechanical work, viz.: the force resulting from the fall of one pound of matter through the space of 772 feet, or of 772 pounds of matter through one foot of space. Later investigations seem to indicate that a higher value (about 778 foot pounds) is more accurate, but nearly all the tables and all work done up to date are based upon the value of 772 foot pounds for the mechanical equivalent of one British thermal unit. (Trustees.)

9. Describe a system of Meter Records by means of which full information in regard to each meter owned by a gas company can be filed so as to be available for ready reference.

Ans. Information in regard to a meter is wanted from various standpoints.

First: There is its physical history as a piece of apparatus, from the time of its purchase to the time of its final disposal by condemnation, including the various kinds of repairs made to it, and its tests for correctness of registration.

Second: There is its location at any given time, whether at a consumers house, or out of use and undergoing repairs, or awaiting setting.

Third: There is the record of the gas passed by it during its various periods of use in consumers' houses.

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As the information above noted is always wanted about each meter as a unit (with the exception of the record of tests, as will hereafter be explained), it is absolutely necessary that every meter be designated by a separate number. The meters as purchased contain the maker's name and a serial number of his own. Formerly, this maker's name and number were used to designate the meter in the records of a company, but experience has shown the wisdom of assigning to each meter, as bought, a number known as a "company's number," entirely distinct from the maker's number. The company's number is generally on a metal badge, which is soldered to the front of the meter-case on one side of the dial. One of its advantages, especially in a small company, over the maker's number in identifying a meter is enabling numbers of four or not more than five figures to be used in place of the six or seven figures of the maker's series, and the ability to omit altogether the name of the maker on all the various cards on which the meter will figure in its life. Again, in repair work, it is more convenient not to be obliged to replace on any meter the same front (containing the maker's name and number) that may have been taken off, and the use of the company's number (which is soldered to the fixed portion of the case), makes the replacing of the same front a matter of indifference.

At the time the meter is bought and badged, a card known as a "meter record" card, and printed like the sample shown, is headed with the number of the meter and filed away in numerical order with other cards of the same kind. Under the conditions obtaining in small companies, all of whose meter setting is done from one shop and whose meter repair work is in the same building as the shop, or in a building adjoining, the presence in the meter record file of a numbered card, filled out with "Size," "Kind," "Maker" and "Maker's No." would indicate that the meter in question was in stock. The record of the meter after it leaves the shop is cared for by having all cards for the setting, changing and removing of meters, after the work is done, pass through the hands of the person responsible for the meter record file. The information on these various cards is posted on the proper meter record card, and in this

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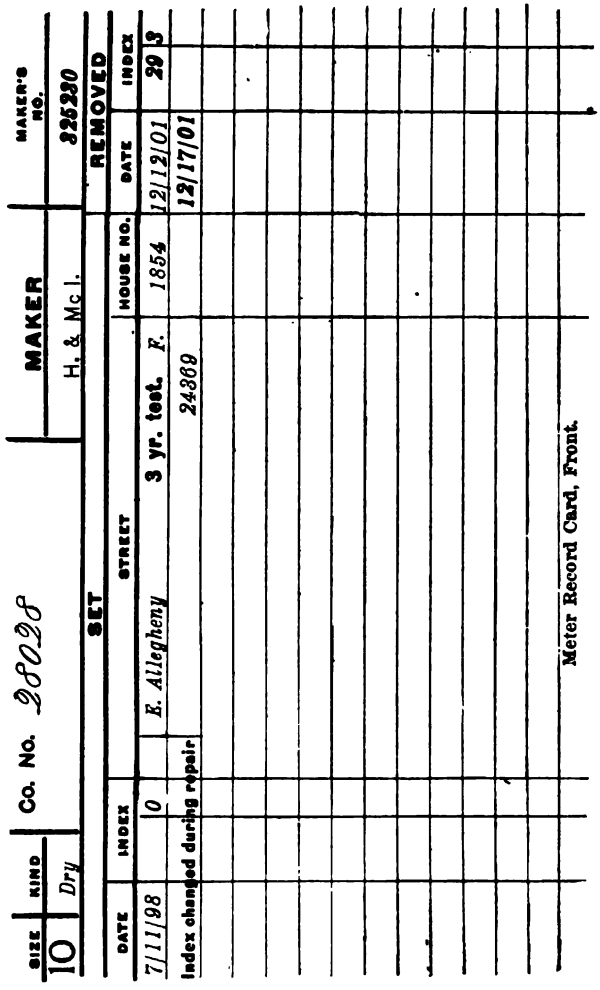
way, knowing a meter number, it is always possible to tell at once its location. For instance, the question arises, "Where is meter No. 19,454?" Turning to the meter record card bear-



ing that number, we see that the last entry shows the meter to have been set at 514 North Eleventh Street, on December 9, 1903. Again, inquiry is raised as to meter No. 4,241. The

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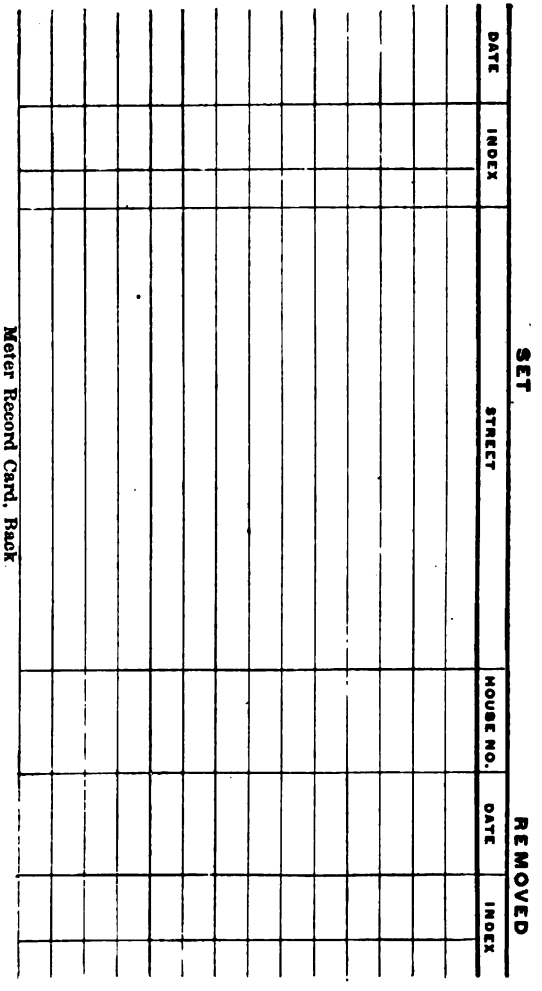
meter record card of that number shows that this meter was removed from 210 South Fourteenth Street on May 15, 1903, and this is the last entry on the card. Therefore, this meter



will be found either in the stock of meters ready to be sent out, or in the meter repair shop being repaired or awaiting repair.

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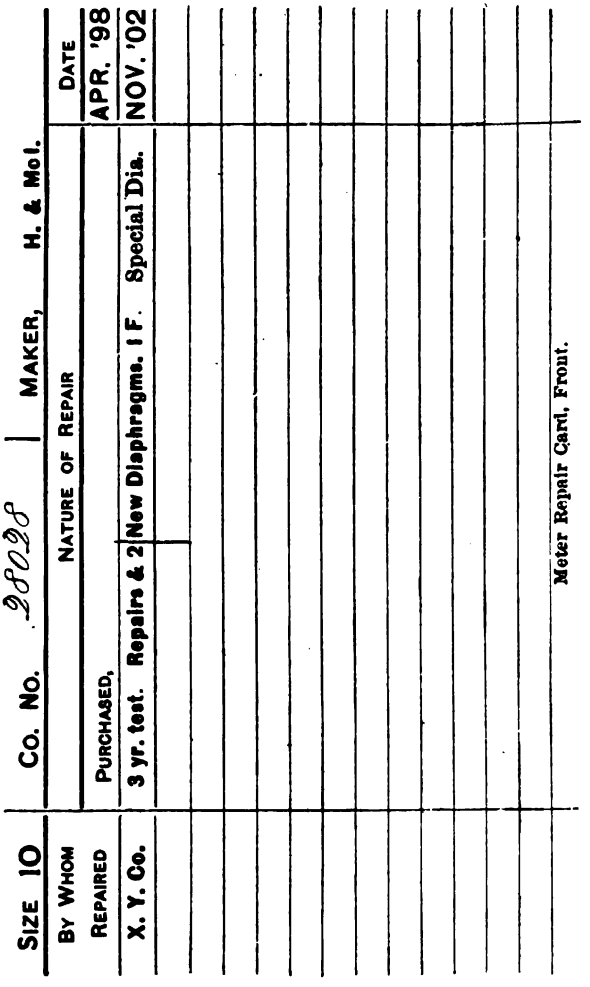
For recording the various repairs made to a meter during its life, a meter repair card, similar to the sample shown, may be used. These cards, like the meter record cards, are filed by



company number. Where a company does its own repairing, as much detail as may be thought advisable in describing the exact nature of repair may be recorded, the idea in such cases

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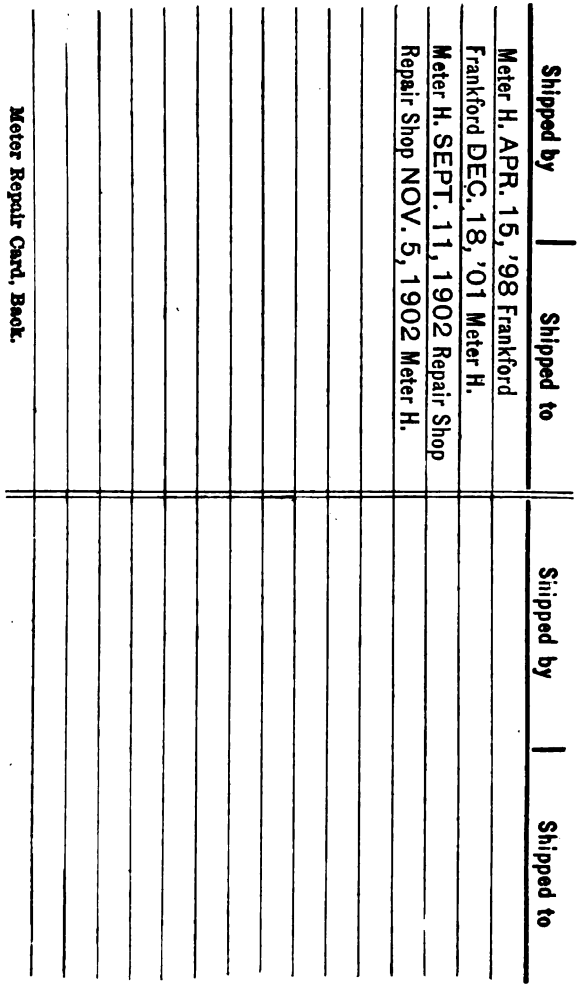
being to get as much information as possible, for use in the future, upon the behavior, for instance, of certain oils or certain leathers. Where the repairing is done by a meter company,


Shipped by
Shipped to
Meter H. APR. 15, '98 Frankford
Frankford DEC. 18, '01 Meter H.
Meter H. SEPT. 11, 1902 Repair Shop
Repair Shop NOV. 5, 1902 Meter H.
Shipped by
Shipped to
Meter Repair Card, Back.

the information on the nature of repair will probably be limited to the commercial terms for the various kinds of repair. The repair card furnishes a convenient means of determining the

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actual location of any meter not in use, a record not given by the meter record card, and which is necessary wherever the company is a large one, or where the meter work is done from more than one shop, or the meter repair shop is in another portion of the city from the meter-fitting shops. In such cases, there are three columns ruled on the back of the meter repair card, and headed "Shipped by," "Date" and "Shipped to." All shipments of meters from the district fitting shops to the meter house (stock of meters awaiting repair), from the meter house to the repair shop, from the repair shop to the meter house (stock of repaired meters), and from the meter house to the district fitting shops, are listed on shipping slips and by posting from these slips to the proper meter repair card, the latter will always show the exact location of the meter. To illustrate the working of this record, we will imagine that information is wanted about meter No. 28,028. The proper meter record card shows it was removed from 1854 East Allegheny Avenue, December 17, 1901. Turning to the meter repair card, we trace, by record of shipments, the meter from the district fitting shop to the meter house and through the repair shop, the last entry showing that on November 5, 1902, it was put among the stock of repaired meters. As all meter stocks are piled by sizes, it would not be a very difficult task to find the meter itself, if it is wanted for any special purpose.

Where, in a large company, the meter repair work is done by a meter company, but for the sake of convenience the meters are all sent from the various fitting shops to one point, from which they are shipped to the meter company, the same shipment record on the back of the meter repair card would trace the meter in every step of its progress, just as it does under the conditions we have already cited.

When a meter is condemned, this fact, with the date, is written on both the meter record and meter repair cards. It is considered advisable to keep all cards representing condemned meters in their proper places, in their respective files, rather than to break the continuity of number by filing the condemned meter cards by themselves. This statement will hold good until such time that, in any series of numbers, the

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proportion of condemned meters is very large as compared with those in use. In such a case, it will probably pay to put the condemned cards by themselves, rather than to have a file, a large proportion of which was composed of inactive cards.

On the sample of the meter record card shown will be noted the index of the meter as set or removed. The opportunity thus afforded of getting on one sheet a continuous record should be taken advantage of for a final check upon the correctness of the meter reading as returned by the men doing the meter work. Every company should have a system by means of which the reading of a meter, as set or removed, is checked several times before the meter card goes from the shop to the office. When, in addition to such checks, the man in charge of the record file is instructed to call attention to any discrepancies which seem indicated by the index record as it comes to him, it will be found that there is little or no chance of any consumer being sent a bill based on errors in reading.

There is nothing inherent in the records kept on the meter record and meter repair cards to prevent these two cards from being combined in one. If such combination was made, the division between the two sets of information might well be a horizontal one, and the card used be about 5 inches by 8 inches. In the case of very large companies, however, it would probably be found more advisable to have separate cards, because of the fact that posting to the two sets of records is done from separate sources, and in actual working it would be found that there would be interference between the clerks engaged in this posting, one being found engaged in posting "record" information in front of the drawers in which were cards needed by another clerk for the posting of "repair" information.

The information thus described as being kept on the meter record card was formerly kept in a book, the "Meter Record Book," and some companies, fearing the loss of a meter card, still prefer the book form.

In addition to the records thus kept of each individual meter, it is important that a record be kept of each proving of a meter as brought in from use, so that (say) a yearly average

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may be obtained of all such proving, indicating the average amount of correctness of all meters brought in. (Trustees.)

10. What is the so-called "Otto cycle" in gas engines?

Ans. The so-called "Otto cycle" in gas engines is a four-phase cycle carried out in a single acting cylinder open at the end toward the crank, and provided with a tightly-fitting piston, which is free to move back and forth.

Starting with the piston at the beginning of an out stroke the cycle is as follows: As the piston moves out on the forward stroke, the charge of gas and air is drawn in and fills the cylinder. The in or back stroke compresses the charge into the clearance space. At the dead point at the end of this second stroke, the charge is ignited and the resulting explosion drives the piston out on its second forward stroke. The succeeding in-stroke expels the products of combustion from the cylinder and the cycle is completed, the piston being in its first position, and ready to repeat the same series of operations. It will be seen that the cycle requires four strokes of the piston for its completion, and that, of these four, the third is the only motor stroke, the power required to carry on the others being derived from the energy stored in the fly wheel during the third stroke. It will also be seen that there is only one explosion for each two revolutions of the fly-wheel.

This cycle was first described and advocated in 1862, by M. Beau de Rochas, and is properly called the Beau de Rochas cycle, but it was not put into practical use until 1876, when it was adopted in the Otto Silent Engine, the first gas engine that was commercially successful and one which held the field almost to the exclusion of all others until the patent expired. (Trustees.)

11. With gas selling at $1.25 per 1,000 cubic feet and electric current at 10c. per kilowatt, what are the comparative costs of one candle power per hour furnished by an incandescent gas light and an incandescent electric light respectively, the cost of renewals being left out in each case?

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Ans. A commercial 16 C. P. incandescent electric lamp will develop 16 C. P. with a consumption of 56 watts per hour, or 3.5 watts per candle power per hour. At 10c. per kilowatt this will cost $\frac{3.5 \times 10}{1000} = \frac{35}{1000}$ =.035c. per candle power per hour.

A good commercial incandescent gas lamp will develop 20 candles per cubic foot of gas per hour, and will therefore require $^1/_{20}$ or .05 of a cubic foot per candle power per hour. The cost with gas at $1.25 per 1,000 cu. ft. is $\frac{0.05 \times 125}{1000} = \frac{6.25}{1000}$ = .00625c. per candle power.

The cost of gas under the assumed conditions is therefore only $\frac{1}{5.6}$ of that of electricity for the same candle power. (Trustees.)

12. What is reinforced concrete? Describe the method employed in building it up and state some of the purposes for which it is suitable.

Ans. Reinforced concrete is concrete which has been strengthened by the imbedding in it of what may be called a skeleton of steel. This skeleton may be built up of rods, bars, or other shapes of structural steel, or formed of wire netting, expanded metal or corrugated sheets, or of a combination of either of the last three with rods. Each special form of construction is, to a certain extent, covered by patents and has its advocates. The increase of strength given by the steel skeleton enables the concrete to be made thinner for the same strength, and also to be used for tensile strains, a use for which ordinary concrete has very little value.

In building up structures of reinforced concrete, the steel skeleton is first put in place and then the concrete is filled in around it in the usual manner. In forming the skeleton it is not necessary to join the ends of the different pieces of steel together, it being sufficient to lap these ends for a greater or less distance, according to the cross section, the adhesion between the concrete and the metal being as great, if the proper

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lap is given, as the strength of the metal. The framework is so placed with reference to the cross section of the concrete and the forces to be resisted as to lie in the position subject to the greatest tensile strains under the conditions of use for which the work is designed.

Reinforced concrete is especially suitable for the arches between the floor beams in fireproof construction, such as the stage floors of retort-houses or any of the floors in gas works buildings. It is also used in the construction of underground tanks, and of coal pockets and sheds. It can be used in any part of the superstructure of any building as a substitute for ordinary masonry or concrete, examples of buildings of different classes having been constructed entirely of reinforced concrete. By its use it is possible to accomplish with ordinary labor almost all the work for which brick and stone masons are generally employed, and the use of the latter can be dispensed with if they are inclined to insist upon onerous conditions in regard to wages or extent of a day's work. (Trustees.)

Fourth Series of Questions—Section of 1909—Practical Class—Trustees Gas Educational Fund.

1. What size of anthracite coal is best suited for use as the fuel in the generator of a carburetted water-gas apparatus? Give the reasons for your answer.

2. Describe the putting into operation of a bench of retorts heated by a generator furnace, from the lighting of the fire to the putting in of the first charge; giving the precautions to be taken to prevent any injury to the setting.

3. Give a description, illustrated with sketches, of one or more forms of the condensers used for cooling illuminating gas during the process of manufacture.

4. Should the speed of an exhauster used for the purpose of relieving the retorts of a coal gas plant from the pressure thrown by the rest of the apparatus be governed in the same way as the speed of an exhauster used for drawing gas from

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the relief holder of a carburetted water-gas plant and forcing it through the rest of the apparatus? Give the reasons for your answer.

5. What is meant by a "unit of heat" or "heat unit"? What is the difference between quantity of heat and intensity of heat?

6. A gas with a specific gravity of .610 is carried by a street main over a hill 78 feet high. The gas is at rest for the time. The pressure in the pipe as shown by a syphon gauge at the foot of the hill is $^{19}/_{10}$ in. What will be the pressure shown by a gauge attached to the pipe at the top of the hill? Give your calculations.

7. In the answer to Question No. 7, Third Series, the yield of ammoniacal liquor per ton of coal is given as 30 gallons of from 8 to 10 oz. (4° to 5° Twaddell) strength. What is the meaning of a degree Twaddell and of ounce when used in this connection?

8. Give a description, illustrated with a sketch of a longitudinal section of both spigot and hub showing outside diameter of spigot, all dimensions of the hub or bell, the shape of the lead groove in the bell, and the depth and finished shape of the lead, of the making of a lead joint in a 6 in. cast iron main. Give also the amount of lead and packing used and the length of time that should be required to do the work.

9. What is a Holophane globe, and how does it affect the useful light given by the source of light over which it is used?

10. In setting a gas range which has an oven burner and four top burners, what size of pipe should be used, and to what size meter should it be connected? Give the reasons for your answer.

11. What are the rules by which to determine the proper size of house piping to be used, when the number of lights to be supplied and the length of pipe along which they are to be placed are known?

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12. Describe the preparation and use of cement mortar for brick work construction, with the precautions to be observed to insure strength and uniformity.

(Answers to these questions are due December 1, 1906.)

Answers to the Fourth Series of Questions—Section of 1909—Practical Class—Trustees Gas Educational Fund.

An answer to a question which is the same as question No. 6, except for the actual figures, can be found on page 137 of Vol. I. of the Proceedings. Answers to questions Nos. 2, 3, 9, 10 and 12 have also been published in the previous volume, and can be found there as follows:

No. 2, Vol. I., page 83.
No. 3, Vol. I., page 131.
No. 9, Vol. I., page 142.
No. 10, Vol. I., page 144.
No. 12, Vol. I., page 148.

The answers to the other questions are as follows:

1. What size of anthracite coal is best suited for use as the fuel in the generator of a carburetted water gas apparatus? Give the reasons for your answer.

Ans. The sizes of anthracite coal that are usually considered available for use as the fuel in the generator of a carburetted water gas apparatus are:

Steamboat, consisting of pieces which pass through a screen in which the bars are set from 4 in. to 7 in. apart, the smaller sizes of coal having previously been screened out.

Broken, consisting of pieces which fall through a screen with a 4-in. mesh, but pass over one with a 2½-in. to 2¾-in. mesh; and

Egg, consisting of the pieces which fall through a screen of 2¼-in. to 2¾-in. mesh, but pass over one with a 1½-in. to 1⅞-in. mesh.

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Of these sizes, that known as broken has been found to give the best results for general use, though in very large generators, those over 8 feet in diameter, the steamboat size might be better.

The advantages possessed by broken coal are, that the lumps are sufficiently large to maintain the bulk of the fire in an open state which affords a ready passage to the air in blasting and the steam when making gas, and yet are small enough to present a large surface of carbon to be acted upon by the oxygen, and it is thus possible to secure the proper combination of the greater portion of both oxygen and carbon in each case. Smaller coal affords a larger total surface, but at the same time forms a large compact mass in the centre of the generator, through which the air and steam cannot pass readily. They, therefore, pass only through that portion of the area of the generator which lies between the outside wall and this compact mass in the centre. The larger size affords a freer fire but much less total surface, and has moreover the disadvantage of being hard to handle in mechanical conveyors.

In a paper on the "Selection of Anthracites for Water Gas," read before the American Gas Light Association, October 20, 1892, Mr. C. R. Collins states that the inactive portion of the fire which is due to the compacting of the coal in the centre of the generator where the lumps can fit into each other more perfectly than they can in the space next the walls "varies with the diameter (of the generator) and with the size of the coal; thus, in a particular generator, egg coal renders about 30% of the fire partially inactive, the bulk of the work being done in the outer parts representing 70% of the fuel; in the same way broken coal affects about 15% of the fuel bed, while steamboat coal leaves a practically free fire." He also states that steamboat coal presents approximately 7 square feet of surface for each cubic foot of generator space; broken coal 10 square feet of surface per cubic foot of space, and egg coal 22 square feet of surface per cubic foot of space. These figures are for selected coal of the standard size in each case. In practice the steamboat coal will increase the size of the inactive portion of the fire as well as the amount of surface presented to the air

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and steam. It is therefore important that no matter what size is being used the smaller pieces and slack should be screened out and not used in the generator, the coal used being kept as near the selected standard size as possible.

The members of the class should read Mr. Collins' paper, which can be found in the Proceedings of the American Gas Light Association, Volume X, page 82; in the American Gas Light Journal, Volume LVII, page 690; and in Progressive Age, Volume X, page 399. (Trustees.)

4. Should the speed of an exhauster used for the purpose of relieving the retorts of a coal gas plant from the pressure thrown by the rest of the apparatus be governed in the same way as the speed of an exhauster used for drawing gas from the relief holder of a carburetted water gas plant and forcing it through the rest of the apparatus? Give the reasons for your answer.

Ans. The speed of a coal gas exhauster should not be governed in the same way as that of an exhauster drawing gas from the relief holder of a carburetted water gas plant, since the two exhausters perform entirely different duties.

That of the coal gas exhauster is to relieve the retorts of the pressure thrown by the rest of the apparatus and to maintain a constant low pressure in the hydraulic main. To do this the gas must be drawn away at exactly the rate at which it is being made at any instant, and as the gas is not made at a uniform rate it is impossible for the coal gas exhauster to run at a uniform speed if it is to perform its duty properly. Its speed must therefore be governed in such a way as to be increased as the rate at which the gas is made increases, and to be decreased as the rate at which gas is made decreases. In this way the pressure at the inlet of the exhauster, and consequently in the hydraulic main, is kept constant.

The sole object of the exhauster in a carburetted water gas plant is to force the gas through the purifiers and station meters into the holders, the pressure thrown by the relief holder being, as a rule, insufficient for this work. Since the

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relief holder compensates for the inequalities in the rate of make, this exhauster can be, and is, run at a uniform speed such that it will handle the gas at a rate equal to the average rate of make, and it must therefore be governed in such a way as to maintain a constant speed, this being varied from time to time to suit the requirements of production. (Trustees.)

5. What is meant by a "unit of heat" or "heat unit"? What is the difference between quantity of heat and intensity of heat?

Ans. In order to be able to express various quantities of heat in comparable terms it is necessary to have a standard unit of heat.

The standard, or "unit of heat" used in this country, is the "British thermal unit," and this is the amount of heat required to raise the temperature of one avoirdupois pound of pure water one Fahrenheit degree from the temperature at which water attains its maximum density, which is 39.1 degrees Fahrenheit. The variation in the quantity of heat required to raise the temperature of a pound of water one degree is so slight for any temperature between 32° and 212° that in general the heat unit may be safely taken as the amount of heat required to raise the temperature of one pound avoirdupois of pure water one degree Fahrenheit. Thus we may say that to raise the temperature of 30 pounds of water from 40° to 60° Fahrenheit requires 600 British thermal units; for we have raised 30 pounds of water through 20° of temperature, and to raise 30 pounds of water one degree requires 30 British thermal units or "units of heat" or "heat units"; and to raise the same quantity through 20 degrees requires 20 times as much, or 600 "heat units."

By quantity of heat is meant the total amount of heat possessed by a body or involved in any thermal operation. It depends not only on the temperature or change in temperature, but also upon the weight of the body affected and the capacity for heat of the substance of which this body is composed. Thus a pound of water and a pound of lead at the same temperature contain very different quantities of heat, since the capacity of the lead for heat is only .0314 times that of water.

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Intensity of heat, or temperature, is entirely independent of quantity, since we may have a small quantity of heat of high intensity, such as the heat in a needle raised to incandescence, or a large quantity of heat of low intensity, such as the heat in a large steel bar at a temperature of say 100° Fahr.

All bodies, no matter what their temperature, within the range of temperatures so far obtained, possess a certain quantity of heat, but no body can impart any of the heat that it possesses to another body unless the intensity of this heat is higher than that of the heat in the body to which it is to be imparted, and this is entirely independent of the relative quantities of heat possessed by the two bodies. Thus a cubic foot of water at a temperature of 60° will possess a greater quantity of heat than a cubic foot of lead at a temperature of 100°, but if they are brought together the lead will impart heat to the water and not the water to the lead.

The amount of heat that can be transferred between different bodies depends upon the quantity of heat possessed by the hotter bodies, and not merely upon the difference in temperature. Thus a pound of water at a temperature of 70° Fahr. can impart more heat to a pound of water at a temperature of 60° Fahr. than can a pound of iron at a temperature of 100° Fahr. From these examples it can be seen that quantity of heat does not depend solely upon intensity, though, of course, for any definite weight of a given substance the quantity of heat possessed will vary directly as the intensity of the heat. (Trustees.)

7. In the answer to Question No. 7, Third Series, the yield of ammoniacal liquor per ton of coal is given as 30 gallons of from 8 to 10 oz. (4° to 5° Twaddel) strength. What is the meaning of a degree Twaddel and of an ounce when used in this connection?

Ans. The statement that an ammoniacal liquor has a strength of a certain number of degrees Twaddel really means that the specific gravity of the liquor is such that a Twaddel hydrometer inserted in it will show a reading of the stated

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number of degrees. As there is a more or less close relation between the specific gravity of ammoniacal liquor and the amount of ammonia that it contains per unit of volume, this Twaddel test affords a rough indication of the strength of any given liquor.

The hydrometer consists of a bulb loaded with mercury or shot, and surmounted by a hollow cylinder above which is a graduated tube, all being made of glass. The bulb is so loaded as to cause the hydrometer to be almost completely submerged when floating in distilled water with a temperature of 60° Fahr. The point on the tube which is even with the surface of the water under these conditions, is marked as the 0 of the scale, which is then continued downward on the tube in degrees and parts of degrees, each degree corresponding to an increase in the weight of the liquid of 5 oz. per cubic foot. The tube is usually made of such a length as to contain a scale reading to 25°. When the hydrometer is placed in a liquid heavier than water, such as ammoniacal liquor, the volume of liquid required to be displaced in order to float the instrument is, of course, smaller than the volume of water required for this purpose, and the hydrometer will not be as deeply submerged as it is in the water. The point of the scale which is at the level of the surface of the liquid when the hydrometer is floating at rest, and not in contact with the sides of the containing vessel, is noted, and the liquid is said to be of a corresponding number of degrees Twaddel strength.

The value of ammoniacal liquor is commercially expressed also by the number of ounces by weight of pure monohydrated sulphuric acid (H_2SO_4) of 1.84 specific gravity, which is required to saturate the ammonia contained in one gallon of the liquor. For instance, the liquor is said to be of 8 oz. strength when it contains per gallon a quantity of ammonia which requires 8 oz. of pure sulphuric acid of 1.84 specific gravity for its neutralization.

In determining the strength in ounces of any sample of ammoniacal liquor, accurate results cannot be obtained by adding the acid directly to the liquor. It is necessary to distill the liquor after adding to it a caustic alkali, such as caustic

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soda or milk of lime, and to use the acid to neutralize the ammonia as it is driven off by this distillation.

It is commonly considered that each degree Twaddel corresponds to a strength of 2 oz., but this is only an approximation, and the strength of ammoniacal liquor should always be determined by the distillation test, which should be specified in all contracts for the sale of such liquor. (Trustees.)

8. Give a description, illustrated with a sketch of a longitudinal section of both spigot and hub showing outside diameter of spigot, all dimensions of the hub or bell, the shape of the lead groove in the bell, and the depth and finished shape of the lead, of the making of a lead joint in a 6 in. cast-iron main. Give also the amount of lead and packing used and the length of time that should be required to do the work.

Ans. In making a lead joint in a 6 in. cast-iron main, the first step in the operation, after the spigot end of one length has been inserted in the bell of the other and the length driven home, lined up and fixed in place by the tamping of a little dirt around the middle of it, is to fill solidly with packing, a portion of the joint space between the spigot and bell, the amount of space so filled being determined by the depth of lead which it is desired to have. For ordinary straight work with 6 in. pipe, the depth of lead may be taken at 1½ in., and the joint space will therefore be filled with packing to a point 1½ in. back from the face of the bell.

Jute packing, either plain or tarred, is usually employed. Packing which has been allowed to absorb a small quantity of tar can be driven tighter than plain packing, but tar being cheaper than jute it is hard to avoid the presence of too much tar in tarred packing, and for this reason plain packing is often given the preference.

A sufficient number of strands of packing should be twisted to form a rope of a diameter a trifle larger than the width of the joint space, and this should be cut into pieces of such length that the ends will come into close contact when a piece is placed around the outside of the spigot end of the pipe and

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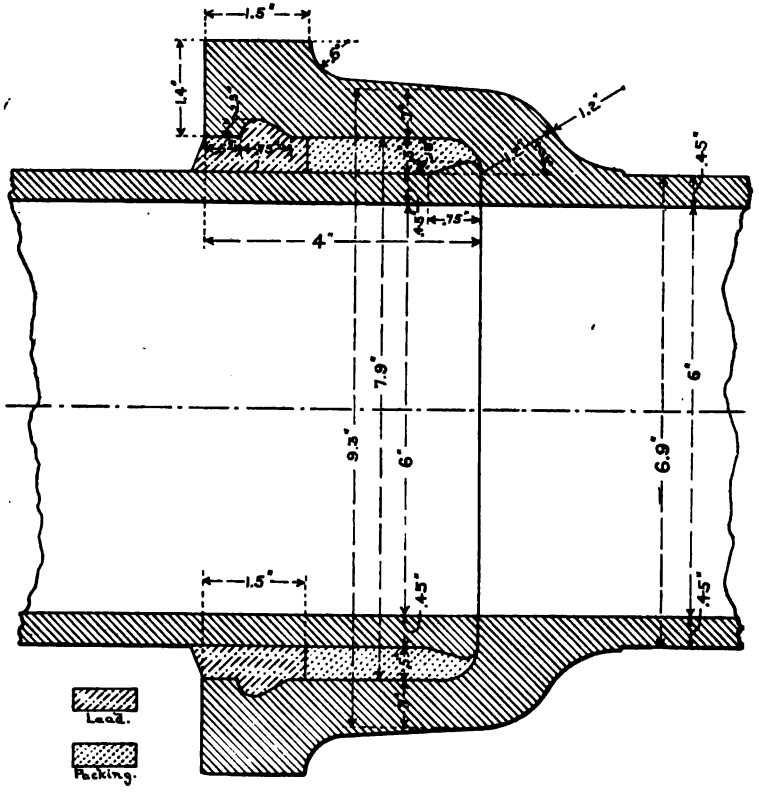
pulled up tight. One of these pieces is used to lift the spigot end as it is inserted into the bell of the pipe previously laid, and is sent home with it, thus keeping the spigot central in the bell and avoiding the necessity of wedging it up after it is in place. This piece of packing is driven solidly into place



Section of 6 in. Bell, Spigot and Lead Joint.
American Gas Light Association Standard.

in the bottom of the joint space by means of a caulking hammer and packing iron, and other pieces are inserted one at a time, the joint in each ring being put, say, one-fourth of the circumference away from the joint in the preceding ring, and each driven home, a sufficient number being used to fill the joint

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space to the required depth, leaving 1½ in. for the lead. The packing must be driven hard and the finished layer must be of uniform depth, so that the lead space will be uniform all around the pipe.

A clay roll or other form of joint runner is then placed around the spigot end of the pipe, being brought tight against the face of the bell, and so set as to leave a triangular space, having its base on the pipe and its apex on the face of the bell slightly above the inside edge, which the lead can fill and thus make it certain that, when driven, the joint will be of the shape shown on the cut. Molten lead is run into the joint and this space until both are completely filled and the lead stands above the highest point on the inside edge of the bell, the lead being poured in through an opening or "gate" left on top of the pipe. When the lead has hardened, the joint runner is removed and the "gate" or lump of lead left where the opening for pouring was made is cut off. The lead is then chiseled all around the pipe with a cold chisel and caulking hammer. This separates the lead from the surface of the pipe and makes a groove in which the first caulking tool, the face of which is about $^3/_{16}$ in. thick, can fit. The lead is driven all around with this tool and then with tools successively increasing in thickness by about ⅛ in. until the full width of the joint has been reached. The work with each tool should be begun at the bottom of the pipe and carried around each way, finishing up at the top. The thickness of the last tool used should not be greater than the width of the joint, and the driving with this tool should cut the lead off sharp with the inside edge of the bell, otherwise there is danger that the force of the blows will be expended against the face of the bell instead of doing the full amount of work that it should do in compressing the lead in the joint. In order to have the tools fit the joints exactly it is well to have them made in sizes varying in thickness by $^1/_{16}$ in., though it is only necessary to use on any joint, tools varying by ⅛ in., the proper sizes being selected. The position in which the tools are naturally held when caulking the joint will give it the finished shape shown on the cut, if the joint runner has been put on properly and sufficient lead used.

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There will be required for making a 6 in. lead joint about 7 to 8 lb. of lead, and 7 to 10 oz. of jute packing. A good workman should be able to average nearly 3 joints an hour for a day's work.

The cut shows the spigot and bell of the standard dimensions adopted by the American Gas Light Association in 1905. (Trustees.)

11. What are the rules by which to determine the proper size of house piping to be used, when the number of lights to be supplied and the length of pipe along which they are to be placed are known?

Ans. There are several sets of rules in use by gas companies for the determination of the proper sizes for house piping, when the number of lights to be supplied and the length of run are known. The majority of these are copied from the English rules, which are apparently based upon a specific gravity for the gas of 0.420, and a loss of pressure of $^1/_{10}$ in. in 30 ft. of piping, and the sizes of pipe determined by them are too small when carburetted water gas, or a mixture of this gas and coal gas, is supplied. In 1897 the American Gas Light Association instructed its Research Committee to prepare a table for house piping based upon a loss of pressure of $^1/_{10}$ in. for each 50 ft. of pipe, with gas of a specific gravity of 0.680. This table was reported by the committee and adopted by the Association in 1898, and is given below:

Diameter. *Inches.*	Length. *Feet.*	Gas per hour. *Cubic Feet.*	Diameter. *Inches.*	Length. *Feet.*	Gas per hour. *Cubic Feet.*
⅜	20	11	1½	150	349
½	30	22	2	200	718
¾	50	60	2½	300	1253
1	70	127	3	450	1977
1¼	100	222	4	600	4059

No greater length of pipe should be used than is given in the table, *e. g.*, the maximum length of 1-inch pipe allowable under any circumstances is 70 feet, and it should not be expected to carry over 127 cubic feet of gas per hour.

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In using this table it is necessary to determine from the number and character of the lights to be supplied the amount of gas which each portion of the house piping system will be required to carry, and, in addition, to obtain from the plans the lengths of these portions. Knowing the quantity of gas and the length of pipe through which it is to be supplied, the table indicates the size of pipe which will pass the required quantity of gas with a loss of pressure equal to or less than $^1/_{10}$ in. in fifty feet. This figure for the loss of pressure was adopted after a long discussion as the one which best met all the requirements. The discussion can be found in Vol. XIV of the Proceedings of the American Gas Light Association, pages 122 to 130, immediately following the report of the Research Committee in 1897. An article on the subject, in which a table slightly different from the above is proposed, will be found in the American Gas Light Journal, Vol. LXXVIII, page 162. This article should be read by the students. (Trustees.)

EIGHTH SERIES OF QUESTIONS, SECTION OF 1908—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Describe two methods employed for "venting" oil storage tanks so as to permit the escape, when the tanks are being filled with oil, of the vapor that has accumulated in them and to prevent the formation of a vacuum while the oil is being pumped out, and state their respective advantages and disadvantages.

2. Describe the cleaning of a badly stopped retort standpipe.

3. Describe one or more forms of steam, hydraulic, compressed air or electric machines for removing coke from retorts.

4. Give a description, illustrated with sketches, of some form of apparatus for separating the oil tar produced in the manufacture of carburetted water gas from its accompanying water, the purpose being to remove all appearance of tar from the works' drainage.

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5. Give a description, illustrated with sketches, of the way in which you would patch a ragged hole, too large to be stopped by a single bolt and washer, in a holder sheet too thin to permit tapping a thread.

6. Name some useful purpose, or purposes, to which tar (coal or oil) can be applied, either in or outside the gas works, and describe the method of preparation and employment for such use.

7. Define the term "specific heat" of a substance. Is the specific heat of a gas, or vapor, at *constant pressure,* that is, when free to expand, as gas in a gas-holder, the same, or more or less, than the specific heat of the same gas or vapor at *constant volume,* that is, when confined, as steam in a boiler? Why?

8. An illuminating gas has the following composition by volume:

Carbon Dioxide	(CO_2)	2.70%
Oxygen	(O_2)	.77%
Illuminants		15.55%
Carbon Monoxide	(CO)	30.75%
Hydrogen	(H_2)	32.45%
Marsh Gas	(CH_4)	13.93%
Nitrogen	(N_2)	3.86%

Calculate the heating power per cubic foot, assuming the illuminants to be composed of Benzol Vapor (C_6H_6), 15%, and Olefiant Gas (C_2H_4), 85%, and the water formed by the combustion of the hydrogen and hydrocarbons to pass off as vapor at a temperature of 212° F.

9. Describe the testing of a consumer's meter. Give all the precautions to be observed.

10. If you were sent to a house to investigate a complaint of "poor gas," how would you proceed to determine the cause of the trouble?

11. When a gas engine is connected to a comparatively small street main, its operation will, unless special precautions are taken, cause a fluctuation in pressure which may affect the

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use of lighting and cooking appliances in the neighborhood. What means would you employ to prevent such a fluctuation in pressure from being produced in the street main when the engine is running?

12. What is meant by the term "bond" as used in speaking of brick-work? What is English Bond? What is Flemish Bond? Give sketches as well as descriptions.

(Answers to these questions are due Jan. 1, 1907.)

ANSWERS TO EIGHTH SERIES OF QUESTIONS—SECTION OF 1908 —PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

An answer to question No. 10 has been published in Vol. I. of the Proceedings, and can be found there on page 259. The answers to the other questions are as follows:

1. Describe two methods employed for "venting" oil storage tanks so as to permit the escape, when the tanks are being filled with oil, of the vapor that has accumulated in them and to prevent the formation of a vacuum while the oil is being pumped out, and state their respective advantages and disadvantages.

Ans. One method for venting oil storage tanks at gas works is to connect the vent pipe either to the gas-holder inlet or outlet, or to some part of the pipe system around the works, such as the foul main.

Another method is to have either a single vent pipe, which branches into two outlets opening into the air, or else to have two vent pipes, and to place a pressure relief valve on one outlet and a vacuum relief valve on the other outlet being careful to keep the open ends of each pipe covered with brass wire gauze of not less than, say, 2,500 meshes to the square inch.

The great advantage of the first method is that it entirely prevents the formation of an explosive mixture of air and oil vapor in the top of the tank, since as oil is withdrawn from the tank its place is taken by gas from the holder or pipe system.

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The disadvantage, which is greatest when naphtha is used and stored in an uncovered tank exposed to the sun's rays, and when the vent pipe is connected directly to the holder outlet or to a pipe to which consumers' services are also connected, is that at times, when the tank is being filled with oil and when the weather is hot, an excessive amount of vapor passes over into the gas being supplied through this pipe and causes it to smoke badly when consumed. This disadvantage is of smaller importance when the tank is roofed over or covered with water, and when heavy oil is used and the vent pipe can be connected into the foul main it practically disappears, and under these circumstances this method of venting is the best possible one.

The second method obviates any such interference with the regulation of the quality of the gas as may result, as stated above, from the first method, but has the great disadvantage of permitting the formation of a mixture of air and oil vapor in the top of the tank, which mixture may be fired and cause more or less damage. It is, however, thought by some good authorities to be preferable to the first method when naphtha is used and stored in tanks exposed to the sun, owing to the trouble experienced under these conditions from the tendency of the vapor-laden gas to smoke. The caps of fine wire gauze placed over the vent pipes should prevent any flame from striking back into the tank, even in case the vapor escaping from the pipes should be accidentally fired. Of course, in normal working no naked light should ever be allowed near an oil tank under any circumstances. (Trustees.)

2. Describe the cleaning of a badly stopped retort standpipe.

Ans. A standpipe may be stopped with soft pitch, with hard pitch, with lamp black or with a mixture of soft pitch and lamp black. If the stoppage is so situated that it cannot be cleaned from the floor with the mouth-piece tools the work must be done from the top of the hydraulic main, the top cap of the standpipe being removed for the purpose.

The first step is to make and maintain as large an opening as possible through the obstruction. If the stoppage is bad it

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may be impossible at first to do more than put through an inch pipe or iron rod, and it may be even necessary to heat this rod before it can be forced through the pipe. Having secured an opening, a wood fire should be made in the front of the retort and the mouth-piece lid partly closed, so that the draft through the opening in the standpipe will draw the flame and hot air from this fire up through the standpipe. This will, after a length of time depending upon the nature and character of the stoppage, burn off the soft pitch and either soften the hard pitch or make it brittle so that it can be cut away by the cutting tools. Should the opening close up after it is first made, as it may if the stoppage is soft pitch, the pipe or rod should be at once employed and another opening made. When a permanent opening through the stoppage is secured the cleaning of the pipe is merely a question of time, and is gradually achieved by increasing the size of the opening so that fresh surfaces of the pitch can be acted upon by the heat.

Should it be impossible to force an opening through the stoppage, even with a red hot bar or pipe, an iron basket kept for the purpose can be clamped to the standpipe at the point where the stoppage is located and the obstruction exposed to the heat of a fire built in this basket until it is possible to make an opening through it. Then a fire should be made in the retort and the operation as outlined above proceeded with.

After a permanent opening is secured, frequent attempts should be made to cut away the obstruction with the proper tools, as much being cut away each time as will come without too much jarring of the standpipe. The pipe should not be considered clean until the pitch and carbon have been so far removed as to permit a ring ¼ inch less in diameter than the pipe to pass freely down the whole length of the pipe.

Ordinarily an opening can be made without resorting to the use of a basket and outside fire, and there are very few stoppages that cannot be softened by the use of the basket and cleaned out with the standpipe in place. If the standpipe has been allowed to become very heavily coated with carbon, as a result of previous incomplete cleanings, it may be so completely

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stopped with this carbon, which requires intense heat for its removal, as to make it impossible to clean it in place In this case it must be taken down and cleaned over a fire in the yard. However, if care is taken never to put a retort in action after a stoppage until the pipe is thoroughly clean, as determined by the test mentioned above, there should be no stoppages which cannot be removed with the pipe in place.

The standpipe should also be cleaned each time the retort is scurfed, for the hot air passing up the standpipe during this operation will loosen the pitch and carbon so that it can be easily removed by the cutting tools. The same test of cleanness should be applied in this case as when a stoppage has occurred and been removed. (Trustees.)

3. Describe one or more forms of steam, hydraulic, compressed air or electric machines for removing coke from retorts.

Ans. The Bronder machine is one worked by steam. It is composed of a carriage, or platform, and of the machinery required for doing the work of drawing the retorts, all of which is mounted on the platform. This is itself carried on wheels running on a track laid on the charging floor of the retort house in front of, and parallel to, the face of the retort stack. The same track serves for both charging and drawing machines, when both are used. On the platform are a steam boiler, an engine for moving the machine along the track, and the rake carrier and rakes for drawing the coke from the retorts together with the mechanism for working the rake carrier. In some installations the boiler is omitted, the steam required for working the machine being obtained from the steam system of the gas works, through a flexible joint which permits of the travel of the machine from end to end of the retort stack.

The engine and mechanism for moving the machine, and stopping it at the proper points in front of the retorts, are similar to those used for the same purpose on the charging machine.

The rake carrier and the rakes, of which there are usually three arranged vertically one above the other, are carried on a

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framework consisting of two uprights, one at the back and one at the front of the platform, properly braced and tied together by horizontal members which form guides on which run the rollers of the rake carrier. This carrier consists of two pieces of plate iron kept the proper distance apart by distance pieces. The four guide rollers are set between the plates, two bearing against the bottom of the upper guide and two running on top of the lower guide. The rake bars, or, as they might be called, the rake handles, pass between the two plates of the carrier and are attached to it by pins going through holes in both plates and in the rake bars which come opposite each other when the bars are in the proper position. If a rake is not needed, owing to the scurfing or repairing of a retort, it is disconnected from the carrier by pulling out the pin and is then fastened to the main carriage by a pin going through an extra hole in the bar and through a corresponding hole in a fixed plate fastened to this carriage. As the rakes are carried backward and forward by the motion of the carrier the bars run on rollers, fixed to a frame, this frame being so arranged that it can be raised and lowered by means of a hand lever worked by the machine attendant. This permits of the rakes being lifted above the coke, as they are pushed into the retort, and dropped so as to engage with the coke and pull it out as they are withdrawn. To this frame a counterbalance is attached in such a manner that the position of the fulcrum, about which it works, is automatically varied to correspond with the extent to which the rake bars project beyond the frame so that the counterbalancing effect is always proportioned to the weight to be balanced.

Motion is imparted to the rake carrier from a piston working in the horizontal steam cylinder of a direct-acting reciprocating motor, the admission of steam to, and its exit from, this cylinder being controlled by suitable valve gear. The rod attached to this piston carries a hollow cross head, in which there is a pin, and upon this pin there turns freely a gear wheel which engages on one side with a fixed rack secured to one of the cross head guides, and on the other side with a flying rack which runs in, or on, the other cross head guide. As the cross head is moved back and forth by the action of the steam

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on the piston, it carries the gear wheel with it, and, as the teeth of this wheel engage with those in the fixed rack, the wheel revolves at the same time that its centre is being carried forward or backward and its circumference has therefore a lineal or longitudinal motion twice the length of that of the piston and cross head. This motion is imparted to the flying rack, every point of which thus moves twice as fast and as far as the piston. This rack carries two wheels or sheaves. A wire rope fastened at one end to the forward part of the main frame passes back to and around the front sheave, then forward to and around a sheave fastened to the front end of the main frame, and then back to be fastened to the rake carrier. Another rope starting from a fastening at the rear end of the main frame passes forward to and around the rear sheaves on the flying rack, then backward to and around a sheave fastened to the rear end of the main frame and thence forward to be in its turn fastened to the rake carrier. As the sheaves on the flying rack are moved, they give to the ropes passing around them lineal motion twice as great as that of their own centres, and this motion is transferred to the rake carrier. Since the sheaves move with the flying rack, which moves twice as fast and as far as the piston, it follows that the rake carrier, which moves twice as fast and as far as the sheaves, moves four times as fast and as far as the piston, and therefore the motion of the rakes over the full length of the retort is obtained with a comparatively small motion of the piston.

The longitudinal motion of the steam piston, and consequently of the rake carrier, is controlled by a hydraulic governor, consisting of a piston working in a water cylinder, the cylinder being arranged on the main frame in line with the steam cylinder, and the piston being attached to a rod fastened to the cross head, this rod being practically a continuation of the steam piston rod. The cylinder is counterbored for a short distance at each end to a diameter slightly larger than that of the piston. In each of these counterbored portions there is a small port opening into a passage which brings the two ends of the cylinder into communication with each other. There are also two more ports at each end opening from the

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body of the cylinder into this passage. The cylinder being filled with water and the piston working in it water tight, the rate of motion of the piston cannot be any greater than the rate at which the water can be transferred from end to end of the cylinder through the ports and the passage. As the piston approaches either end of the cylinder it covers first one and then the other of the ports opening out of the body of the cylinder and thus its speed is reduced gradually. The ports in the counter bores being always open the governor does not bring the piston to a full stop, but its speed is so reduced that its motion can be controlled by the steam valve without incurring any risk of knocking out the end of the retort. An enlargement in the water passage, forming an air chamber, provides for the space occupied, on one side of the piston only, by the piston rod, the excess water forced out of the side on which there is no rod and for which there is no room on the other side of the piston, owing to the presence of the rod being retained in this chamber.

In operating the machine it is brought to the right point by the traversing engine, and the retort lids having been slacked off, the rakes are run forward into the retorts, being kept raised during their forward motion. When about one-third of the way back into the retorts the rakes are stopped, dropped into the coke and withdrawn, bringing out ahead of them the coke from the fronts of the retorts. They are then raised, run back a little farther than before, dropped and withdrawn, the operation being repeated until the rakes have reached the back of the retort and all the coke has been drawn out. The rakes are then brought back to their original position on the machine and this is moved to the next set of retorts to be drawn, and the whole series of operations repeated.

West's drawing machine, like the charging machine, is worked by compressed air. As made for large works, it is mounted on a separate carriage from the charging machine, but for medium-sized works both machines are mounted on the same carriage so that both can be operated by the same man.

In its separate form the machine consists of an upright frame mounted upon four wheels, which run on rails laid in

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the retort house floor, these rails being used in common by both the drawing and charging machines. This main frame is moved along the rails either by a hand wheel and gears or by a compressed air motor and gears.

Suspended from it in a position perpendicular to the face of the stack of retorts is a horizontal frame, made of channel irons, in which works the drawing rake bar. The chains supporting this frame are fastened, not to the frame itself, but to what may be called a cross head working in guides on the upright frame, and pass over pulley wheels at the top of the upright frame and then run down to a hand winch, by which the rake frame and rake can be raised and lowered to the heights of the various tiers of retorts. The rake frame is pivoted in the cross head so that the front end of it and the rake can be raised to let the rake pass over the coke as it makes the forward stroke into the retort and lowered to force the rake down into the coke and bring the latter with it as it is withdrawn.

The power for driving the rake back and forth and withdrawing the coke is furnished by a piston driven up and down in a vertical cylinder by means of compressed air admitted alternately above and below the piston. Fastened to the piston is a rod carrying a rack, the teeth of which engage in those of a pinion on the axle of a chain drum. To this drum two chains are attached in such a way that as one is wound up the other is unwound. The drum is made in two parts, one for each chain, which, while they move as one when the machine is in operation, can be moved separately in order to take up the slack of the chains when the rake is raised from a lower to a higher level and to pay out the chains when the rake is lowered. One chain runs from the drum down to and partly around a pulley wheel carried on the upright frame, then forward to and partly around a pulley wheel fixed on the forward end of the rake bar frame, and then back to be fastened to the back end of the rake bar. The other chain runs from the drum down to and partly around a wheel on the upright frame, then back to and partly around a wheel on the rear end of the rake bar frame

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and forward to be also fastened to the back end of the rake bar at the same point as the first chain.

Compressed air is brought to the machine by a flexible hose, and its admission to the cylinder is regulated by means of a valve chest and a slide valve. Five ports open into the valve chest, there being a separate exhaust and admission port for each end of the cylinder and an exhaust port opening to the outer air. The admission ports open into the cylinder next to the heads and each is provided with a check valve so set that it will open under pressure from the slide valve side and close when this pressure is removed, or a greater pressure is applied from the side toward the opening in the cylinder. The exhaust ports open into the cylinder at some little distance from the heads, so that as the piston nears the end of its stroke, in either direction, it closes off the corresponding exhaust port and is brought gradually to rest by the compression of the air still left in that end of the cylinder. The slide valve is an ordinary D valve except that it contains a by-pass passage which puts the two ends of the cylinder in communication with each other, and thus permits the pressure to be equalized on both sides of the piston, when the valve is in its middle position. The valve is operated by a hand lever to which are connected two tappet levers for automatically putting it in its middle position just as the piston reaches either end of its stroke.

In operating the machine the rake bar is set at the proper height for the tier of retorts to be drawn, and the machine is moved opposite the first retort in the series. The operator, with one hand on the air valve lever, moves this so as to admit air into the bottom of the cylinder. This raises the piston and revolves the chain drum so that the rake is pushed forward into the retort, the operator, by means of the rocking lever in his other hand, raising the rake above the coke. When it has gone in far enough he reverses the air valve, thereby first equalizing the pressure on both sides of the piston and then admitting air into the top of the cylinder, and at the same time drops the rake into the coke. The pressure of the air on top of

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the piston forces it down and moves the drum in the opposite direction, withdrawing the rake from the retort and bringing the coke with it. As the piston nears the bottom of the cylinder it shuts off the bottom exhaust port and compresses the air ahead of it until it is brought to a stop just as the tappet lever moves the slide valve to its middle position and allows the pressure to be equalized in both ends of the cylinder. The operator then pushes the valve over to admit air into the bottom of the cylinder and the process is repeated, the rake going farther into the retort at each stroke until all the coke is drawn out. When going in to the extreme distance on the last stroke, the air is cushioned ahead of the piston in the upper end of the cylinder just as is done at the bottom on each stroke. This cushioning at the bottom prevents the rake from being withdrawn clear of the retort, so a relief port is provided in the bottom head of the cylinder. This port is fitted with a valve, normally kept closed by the pressure in the cylinder, which, when the drawing of the retort is finished, is raised by the movement of a third lever. As the air escapes through this open valve the piston drops and the rake is completely withdrawn from the retort, and the machine can be moved into place in front of the next retort and the above operations repeated.

Sometimes a small water tank is placed on top of the upright frame and water from this tank is allowed to run on the rake head to cool it when it is drawn out of the retort.

This machine has recently been installed in a few works in the United States.

As a companion machine to the De Brouwer projector a ram worked by electricity is used to push the coke out of through retorts, that is, retorts open at both ends, and in one installation in this country a similar ram worked by compressed air is used in connection wth the West charging machine, the two being mounted upon the same carriage and worked by the same operator. (Trustees.)

4. Give a description, illustrated with sketches, of some form of apparatus for separating the oil tar produced in the manufacture of carburetted water gas from its accompanying

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water, the purpose being to remove all appearance of tar from the works' drainage.

Ans. An effective apparatus for separating the oil tar produced in the manufacture of carburetted water gas from its accompanying water, is shown in the cut, and consists of an oblong rectangular box of wood or iron, say 4 feet wide, 5 feet deep and 16 feet long, buried in the ground to such a depth as to receive all wash box and drip water, and to empty into a sewer or other drain. This box is provided with a series of cross partitions at intervals of 18 in. or 2 feet, every other partition reaching from within, say, 5 inches of the bottom of the box, to within 4 to 6 inches of the top surface of liquid in box. Alternating with these partitions are others which reach from within 2 feet of bottom of box, up above surface of liquid, and are called skimmers. The liquids to be separated are admitted at one end into the box (if possible from a height of several feet), falling on an iron plate and thence flowing through separator. This striking of tarry liquids on iron plate helps to break up the vesicles of tar and water. Another way would be to urge the stream of tarry water against a plate, by aid of a steam jet. The liquid flows, the slower the better, over and under the partitions, each reversal of current helping to precipitate the tar to the bottom; any light oils come to the top surface, and are held by the skimmers until removed.

The wider and deeper the box, the slower the motion of a given quantity of fluid per hour; the longer the box, the more complete the separation. The higher the bottom of skimmers from the bottom of the box, the greater the capacity of the box to hold the separated tar between periodical drawings off. The bottoms of the other partitions are only above bottom of box, to enable accumulated tar to be drawn off from one end; the tar will never be completely drawn off, so that there is no danger of liquid flowing direct from one end of box to other under partitions.

Bottoms of skimmers should not be too high above bottom of box, however, for total depth of box, or the zigzag reversals of current would be too slight. Keep box covered with

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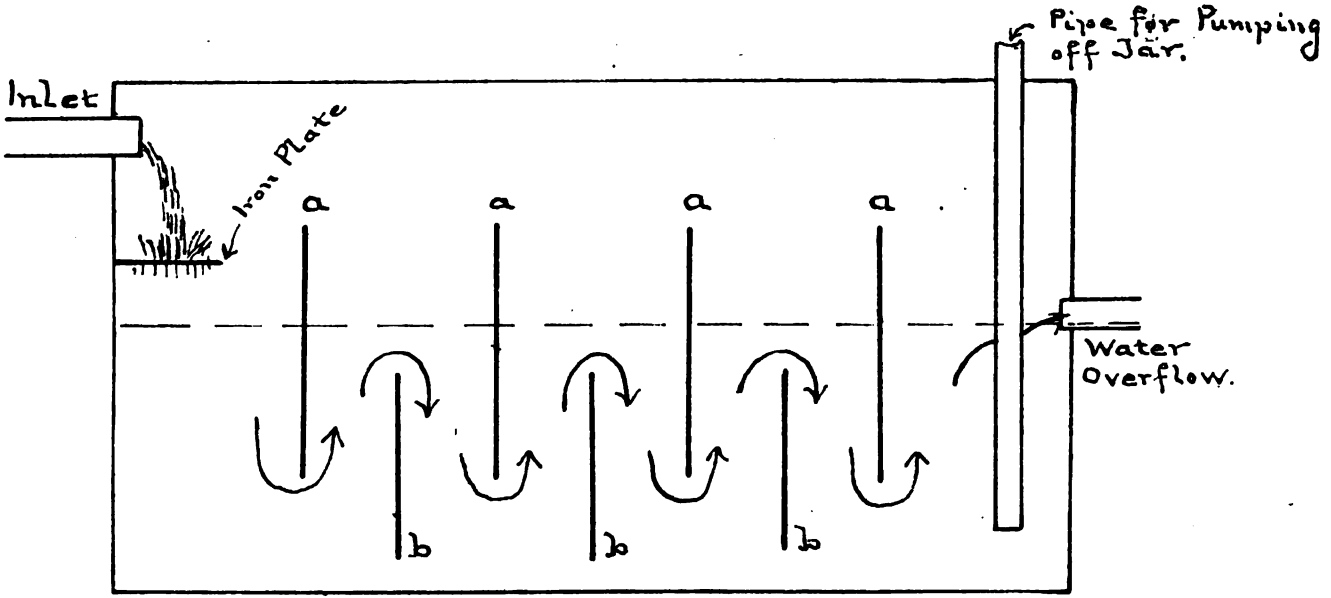

a a. Skimmers. b b. Partitions.

Jar and Water Separator.

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hatches, if necessary warm with steam pipes in winter to keep temperature about 150° Fahr. (Trustees.)

5. Give a description, illustrated with sketches, of the way in which you would patch a ragged hole, too large to be stopped by a single bolt and washer, in a holder sheet too thin to permit tapping a thread.

Ans. Although the finished work would be the same in every case the temporary measures adopted to prevent loss of gas while the preliminary work of preparation was being carried on would depend upon the location and character of the hole to be patched. If this is in the crown a plate smeared with clay or a putty of some kind can be laid over the opening and weighted down. If the hole is in the side of the holder and is small it can be stopped with waste, but if large it may be necessary to keep it under water until the patch is ready to be applied.

This patch should be made of wrought iron or steel plate of about the same weight as the holder sheet, the piece taken being cut of such size and shape as to extend well beyond the edges of the hole on all sides. Oblong holes, say, 1 in. long by $^{5}/_{16}$ in. wide, with the long axis at right angles to the edge of the plate, about 2 in. apart and with ½ in. space between the outer ends of the holes and the edge of the plate, should be made all around the perimeter of the patch. The heads of a sufficient number of ¼ in. bolts should be flattened until they are only ¼ in. wide. The patch should then be applied to, and held against the sheet over the hole until bolt holes are made in the sheet to correspond with those in two diagonally opposite corners of the patch. It can then be bolted temporarily to the sheet by passing the flattened head of one of the prepared bolts through each hole, giving the bolt a quarter turn so as to bring the head at right angles to the hole, placing a washer over the end of the bolt and screwing down the nut. (A string should be tied to the bolt in order to hold it while the nut is being screwed on.) Putty can then be smeared around the edge of the patch to stop the escape of gas and the work of making the other holes in the sheet proceeded with. These

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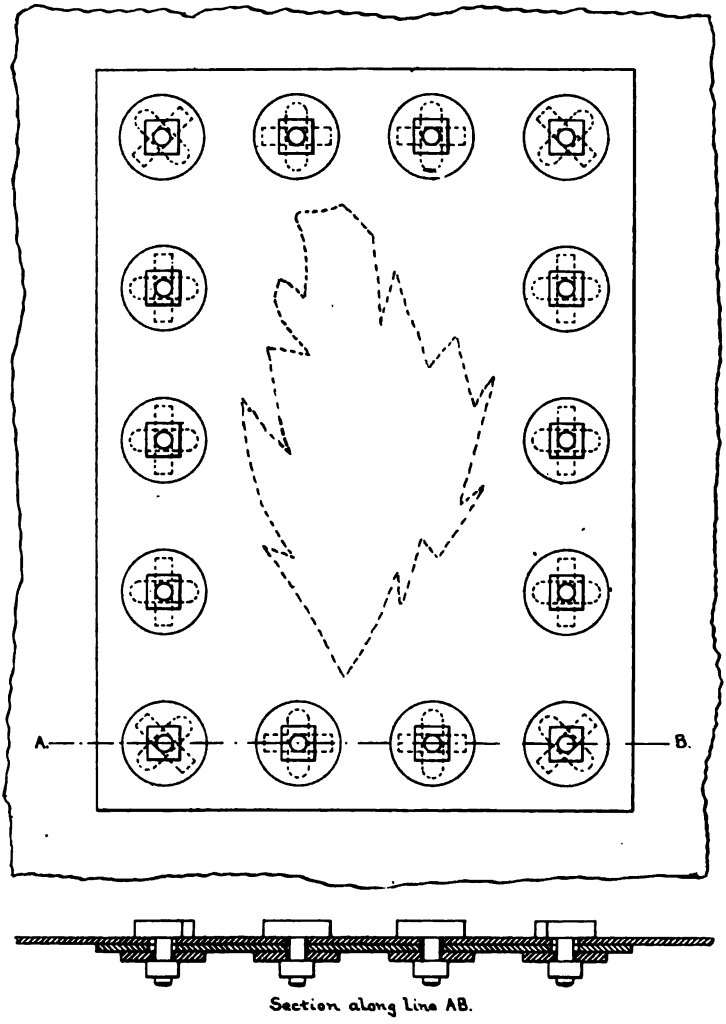

Section along Line AB.

Completed Patch over Ragged Hole in Holder Sheet too thin to Jap.

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holes can be made by means of a breast drill and a round file, or in any other convenient way that will not bend in the sheet around the edges of them, and as each one is made it can be stopped with waste. When the holes are all made the patch should be unbolted and removed, another piece of iron being pressed against the opening to prevent the escape of gas, and a putty made of equal parts of red lead and litharge mixed in glycerine spread over the side that goes against the holder. It is then reapplied to the holder and bolted on permanently, the hole around each bolt being filled in with putty before the washer is put on and a grummet of lamp wick smeared in the putty being used under both the washer and the nut. The washers used should not be less than 1¼ in. in diameter, in order to lap over the hole in its longest dimension. Care must be taken to use bolts on which the nuts turn easily, so that there will be no trouble from the nut and bolt turning together before the nut comes down tight on the patch.

If the patch is a large one applied to the side of the holder it will be well to provide some means of holding it up until it is held by the bolts. This can be done by an eye bolt fastened by nuts on each side of the plate, the eye and the piece of the bolt projecting beyond the outside nut being sawed off when the job is finished. (Trustees.)

6. Name some useful purpose, or purposes, to which tar (coal or oil) can be applied, either in or outside the gas works, and describe the method of preparation and employment for such purpose.

Ans. (A) As a paint.
(B) As a sidewalk pavement.

(A) The tar must have less than 1 per cent. of water in it to be readily boiled down without the use of special stills. Concentrate the tar by boiling until it will "string" between thumb and forefinger when cooled to 60° F. When ready to use as paint, heat in quantity required for six hours' use, to about 150° F., stir in benzine in the proportion of one gallon to four of the tar. Apply hot, though as it gradually cools it can be used nearly as well, and sometimes the tar has been

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thinned as above while cold and used without heating, and has given satisfaction.

Naphtha is sometimes used instead of benzine. Paraffine oil is also employed as a thinner of the tar. Lime is also considered by some a necessary ingredient, but if used as mentioned here, the paint will prove durable and give a hard, smooth surface.

(B) For pavement for sidewalks, applied as a finishing surface 2 to 3 inches thick upon a foundation of broken stone or coarse clinkers, the top dressed with finer ashes or coke breeze, boil the tar until at 60° F. it has the consistency of vaseline. In the absence of special furnaces for the work, place a sheet of boiler plate upon stones, in the vicinity of the paving to be laid, so that it will be about one foot above the ground. On this plate throw building sand and underneath kindle a fire of wood or coke. Turn the sand over with a shovel until well heated. Gradually pour on the thick tar, meanwhile turning and mixing the mass until the sand is uniformly black and of such a consistency that a ball of it will just hold together while hot. While hot, and carrying the mixture in heated iron barrows or on shovels, apply where required, level with a hot rake and ram with a hot rammer. Then sprinkle the surface with fine sand and roll, using preferably a heavy hand roller. This may be made of a piece of cast iron street main, with ends plugged and centre filled with sand. (Trustees.)

7. Define the term "specific heat" of a substance. Is the specific heat of a gas, or vapor, at *constant pressure,* that is, when free to expand, as gas in a gas-holder, the same, or more or less, than the specific heat of the same gas or vapor at *constant volume,* that is, when confined, as steam in a boiler? Why?

Ans. "Specific heat" as used in the question denotes the amount of heat expressed in heat units which is required to raise by 1° the temperature of unit weight of a substance. Since a heat unit is the amount of heat required to raise by 1° the temperature of unit weight of water, the specific heat of a

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substance is the ratio between the amount of heat needed to raise by 1° the temperature of unit weight of the substance, and the amount of heat required to raise by 1° the temperature of unit weight of water. If the unit of weight is the pound avoirdupois and the temperature is measured in Fahrenheit degrees, the specific heat is expressed in British thermal units, while if the unit of weight is the kilogramme and the temperature is measured in Centigrade degrees, the specific heat is expressed in calories. It is expressed by the same number in each case. More heat is required to raise the temperature of unit weight of water a given amount than is needed to raise by the same amount the temperature of unit weight of any other substance, with the exception of hydrogen; therefore, with this exception, the specific heats of all substances are less than 1.

The specific heat of a gas or vapor, when free to expand, is more than the specific heat of the same gas or vapor when confined; that is, it requires more heat to raise the temperature of a given volume of gas or vapor from any point to a higher point when free to expand, than to raise the same volume through the same range of temperature, the gas or vapor being confined. The reason for this will be evident after a little thought. In raising the temperature of a confined gas or vapor, as steam in a boiler, it is only required to add the heat necessary to increase the temperature of the gas or vapor from the point at which it starts to the desired temperature. If, however, the gas or vapor is free to expand, it will expand as heated, and in expanding it must displace, or lift the atmosphere pressing upon it, an amount equivalent to the expansion. Thus, if the gas is in a holder having an area of 100 square feet, as its temperature increases, the gas expands, and the holder rises, say, one foot. Now, the holder has done mechanical work equivalent to lifting the entire weight of the portion of the atmosphere bearing upon the holder (about 15 lb. for every square inch of the area of the holder), through one foot in height, and the heat necessary to the accomplishment of this work must be supplied to the gas, and is in addition to the

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heat necessary to raise the temperature of the gas if confined. (Trustees.)

8. An illuminating gas has the following composition by volume:

Carbon Dioxide,	(CO_2)	2.70%
Oxygen,	(O_2)	.77%
Illuminants,		15.55%
Carbon Monoxide,	(CO)	30.75%
Hydrogen,	(H_2)	32.45%
Marsh Gas,	(CH_4)	13.93%
Nitrogen,	(N_2)	3.86%

Calculate the heating power per cubic foot, assuming the illuminants to be composed of Benzol Vapor (C_6H_6), 15%, and Olefiant Gas (C_2H_4), 85%, and the water formed by the combustion of the hydrogen and hydrocarbons to pass off as vapor at a temperature of 212° F.

Ans. Since, as stated in the question, the water formed by the combustion of the hydrogen and hydrocarbons in the gas passes off as vapor, the net calorific values of the hydrogen and hydrocarbons must be employed in the calculation. The answer to Question No. 9 of the Sixth Series gives the net calorific values per cubic foot of the various combustible components of the gas as follows:

Benzol Vapor,	(C_6H_6)	3572	B.t.u.
Ethylene or Olefiant Gas,	(C_2H_4)	1515	"
Carbon Monoxide,	(CO)	325	"
Hydrogen,	(H_2)	275	"
Marsh Gas,	(CH_4)	910	"

Carbon dioxide, oxygen and nitrogen, not being combustible, have no heating value.

Each 100 cu. ft. of the illuminating gas under consideration contains,

2.33 cu. ft. of Benzol Vapor,
13.22 " " Olefiant Gas,
30.75 " " Carbon Monoxide,
32.45 " " Hydrogen,
13.93 " " Marsh Gas,

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and therefore the calorific value derived from the quantity of each of the components contained in 100 cu. ft. will be,

2.33	× 3572	=	8322.76	B.t.u.
13.22	× 1515	=	20028.30	"
30.75	× 325	=	9993.75	"
32.45	× 275	=	8923.75	"
13.93	× 910	=	12676.30	"
	Total,		59944.86	

and that of one cubic foot of the gas will be 599.4 B.t.u.

This is the net heating power of the gas. The gross heating power would, of course, be larger, but it is the net heating power which is important under the conditions under which gas is generally burned.

It is interesting to note that of the total net or available heating power of the gas there is derived, in round numbers, 47% from the illuminants, 17% from the carbon monoxide, 15% from the hydrogen and 21% from the marsh gas. (Trustees.)

9. Describe the testing of a consumer's meter. Give all the precautions to be observed.

Ans. Consumers' meters should be allowed to remain in the same room with the meter-prover at least one hour before testing, to allow the meter to become of the same temperature as the air and water in the meter-prover. Meters should undergo three distinct tests.

First. Test for registration on a small flame, about the size of a small copper cent; this is to detect any leakage in the valves, or any holes in the diaphragm. If no registration appears when this test is made, the meter should go to the shop for examination.

Second. Test for irregularity of delivery, to show any stiffness or derangement of the internal mechanism of the meter. To give the test the greater precision, the meter should be connected to a cluster or line of lights, of, or near its full capacity, and if there is any irregularity in the working of the

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meter, it will show in fluctuation of the flames, and the meter should go to the shop.

Third. If both of the above tests show that the meter is in good working order, the third test should be for accuracy of registration.

When the meter has been connected to the prover, one or more cubic feet of air should be allowed to pass through the meter, to expel the gas remaining after the first two tests, then bring the hand on the prover, and the test hand on the meter to zero, open the air passage between the prover and meter and allow the air under the prover-cylinder to pass through the meter, and when the test hand arrives at zero again, the scale on the prover shows to what extent, if any, the meter was in error. If the meter shows not more than 1 per cent. fast or 1½ per cent. slow, it is considered correct, but beyond these limits it should go to the shop for adjustment or other repair, as examination may dictate.

All meters when not in use should be kept tightly corked, and no meter should be set which has not been tested within thirty days. (Trustees.)

11. When a gas engine is connected to a comparatively small street main, its operation will, unless special precautions are taken, cause a fluctuation in pressure which may affect the use of lighting and cooking appliances in the neighborhood. What means would you employ to prevent such a fluctuation in pressure from being produced in the street main when the engine is running?

Ans. This question was brought up and discussed at a meeting of the American Gas Light Association, and several methods of overcoming the fluctuation of pressure were described.

The simplest method, which, however, applies only where the load is fairly constant, is to put a stop cock on the inlet to the gas bag and, by partly shutting the cock, compel the gas to pass into the bag at a practically uniform rate just sufficient to supply the quantity of gas required by the engine. The bag

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acts as a reservoir which is emptied when the engine draws gas, and is filled again during the interval between explosions, and as the pull on the portion of the pipe in front of the stop cock is kept more constant the fluctuation in pressure is reduced. This method will give slightly better results when two bags are used in tandem instead of one. When it is employed care must be taken not to shut off the stop cock to such an extent as to prevent the engine from getting all the gas it requires and thus to prevent it from developing the power needed.

A more elaborate method based upon the same principle is to use a diaphragm governor followed by a reservoir or tank from which the engine draws its gas. An ordinary kitchen boiler will make a good reservoir. Some times a length of pipe of a diameter larger than that of the rest of the run between the regulator and the engine is used as the reservoir.

This method gives good results with engines running at relatively high rates of speed or with multiple cylinder engines which draw gas at a comparatively steady rate, but with large single cylinder engines running at slow speeds the simple reservoir must be made very large. In such cases a reservoir is used which is partly filled with some non-volatile liquid, one portion of the surface of which is in communicaton with the outside air, while gas stands in the part of the reservoir over the rest of the surface. This part of the reservoir is in direct communication with both the engine and the service pipe. When the engine pulls gas the pressure in the reservoir is reduced, and the air acting on the liquid forces it up into the gas space, and thus drives gas out from this space to the engine. In the intervals between the suction strokes of the engine the supply of gas in the reservoir is replenished from the service and the liquid brought back to its normal level.

A small gas holder will, under the same conditions, absolutely prevent the passing back to the street main of any fluctuation in pressure, no matter how much the load varies, but such a holder is comparatively expensive.

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All of these methods employ the same principle, that of having a store of gas, fed at a constant rate, from which the engine can draw its supply without reducing the pressure as much as if it drew directly from the service. (Trustees.)

12. What is meant by the term "bond" as used in speaking of brick-work? What is English Bond? What is Flemish Bond? Give sketches as well as descriptions.

Ans. "Bond" in brick-work denotes the uniform system in accordance with which the bricks are placed in the wall.

English Bond is a system in which all the bricks in any one course are either headers (bricks laid with their length perpendicular to the face of the wall), or stretchers (bricks laid with their length parallel to the face of the wall). Sometimes the courses of headers and stretchers alternate, but usually there are several courses of stretchers for each course of headers. In ordinary walls the proportion of stretcher courses to header courses is sometimes made as high as seven to one, but this makes a wall which is weak transversely, since stretchers give longitudinal strength and headers transverse strength. For the walls of gas works buildings, at least one course in four should be laid in headers. One course of headers in three courses gives equal strength longitudinally and transversely.

In laying bricks in English Bond, care must be taken to make the vertical joints in the header courses thin, so that the two headers and the vertical joint between them will not take up a greater length than the stretcher, and prevent the correct breaking of the joints by one-quarter of a brick.

Flemish Bond is a system in which the bricks in each course are alternately headers and stretchers, the outer end of each header lying on the middle of a stretcher in the course below. There are the same number of vertical joints in each course and there is, therefore, nothing to prevent the proper breaking of these joints. Brick-work laid in Flemish Bond presents a neater appearance than does that laid in English Bond, but the latter is stronger than the former. (Trustees.)

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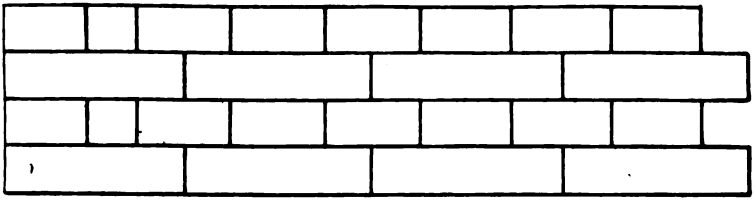
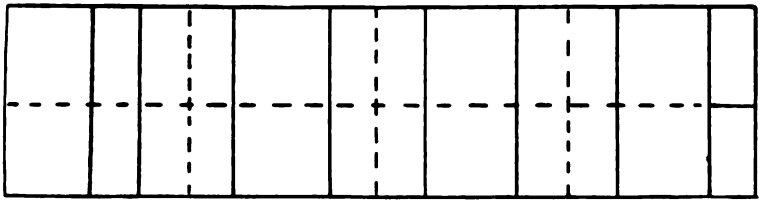
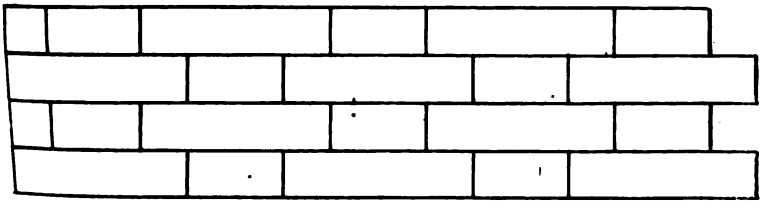
Elevation.



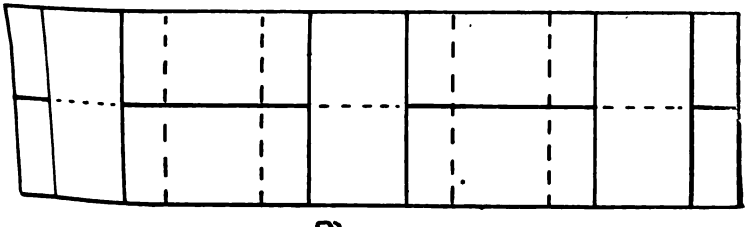


Plan.

English Bond.



Elevation.



Plan.

Flemish Bond.

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Twelfth Series of Questions—Section of 1907—Practical Class—Trustees Gas Educational Fund.

1. What is the fuel value of the oil tar produced in the manufacture of carburetted water gas, and consequently what is the price that should be obtained per gallon to make it worth while to sell, instead of burning it? The price of steam coal may be taken as $3.80 per net ton.

2. Has any conveyor been successfully applied to receive the hot coke as it comes from the retorts and transport it to the coke yard, the coke being quenched in transit? If so, give a description of it, illustrated with sketches.

3. Give a description of a furnace and setting for horizontal return tubular boilers suited for the use of coke breeze as the boiler fuel, and state how you would obtain the draft required for the combustion of the fuel.

4. How can the weight of water evaporated per pound of fuel by a boiler under ordinary conditions be determined approximately?

5. What are the arguments for and against anti-dips?

6. What are the respective arguments in favor of the use of lime and of iron oxide for purification?

7. Describe an arrangement by which the percentage of air admitted for continuous revivification of the oxide in the purifying boxes can be kept under control.

8. Upon what property of illuminating gas does the amount of light that it will give per cubic foot when used in an incandescent burner depend?

9. Having taken charge of the engineering work of a gas company showing a large amount of unaccounted-for gas, how would you proceed to determine how much of this was due to actual loss from leaks in the mains and services and how much was due to other causes?

10. Describe a method of filing and reporting upon orders for setting and removing meters which makes it certain that all

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such orders are properly attended to and that the changes of meters made in carrying them out are properly recorded. Include in your answer the system of checks necessary in order that the reading of all meters set and removed may be correctly made and recorded.

11. The inventor of a patent process for making gas claims that it uses only 12 lb. of bituminous coal and 2.4 gallons of Ohio crude oil per 1,000 cu. ft. of gas made and that the gas has a calorific value of 502 B.t.u. per cubic foot. How can it be shown that the above claim is impossible of realization?

12. What are the precautions that should be taken in laying fire brick and fire clay blocks to secure for the finished work strength and the ability to resist heat?

(Answers to these questions are due February 1, 1907.)

ANSWERS TO TWELFTH SERIES OF QUESTIONS—SECTION OF 1907—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

Answers to questions Nos. 4 and 12 have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 4, Vol. I., page 108.

No. 12, Vol. I., page 126.

The answers to the other questions are as follows:

1. What is the fuel value of the oil tar produced in the manufacture of carburetted water gas, and, consequently, what is the price that should be obtained per gallon to make it worth while to sell, instead of burning it? The price of steam coal may be taken as $3.80 per net ton.

Ans. The only information that has been published, as far as is known to the Trustees, as to the fuel value of the oil tar produced in the manufacture of carburetted water gas is that given in a paper, "The Fuel Value of Residuals," read by Mr. Chas. F. Prichard at the meeting of the American Gas Light Association in 1901.

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Mr. Prichard took as a basis of value a first-class steam coal having a calorific value of 14,385 B.t.u. per pound and giving an evaporative duty per pound, under every day working conditions in the boilers of an electric light plant, of 9.8 lb. of water from and at 212°. The cost of this coal is, in the question, assumed as $3.80 per net ton.

The calorific value of the oil tar used by Mr. Prichard, as determined by a bomb calorimeter test, was 17,193 B.t.u. per pound, and the average evaporative efficiency per pound, when used under boilers under the same conditions as the coal, was 14.9 lb. of water from and at 212°. As the weight of a gallon of this tar was 9.58 lb. the weight of coal equivalent for use as boiler fuel to a gallon of tar can be found from the proportion $x : 9.58 = 14.9 : 9.8$ according to which $x = \frac{9.58 \times 14.9}{9.8} =$ 14.56 pounds. Since the coal is worth 0.19c. per pound the value of the tar for fuel purposes is 0.19c. $\times$ 14.56 = 2.8c. per gallon, and if it cannot be disposed of at this or a higher price it should be burned.

Mr. Prichard's paper can be found in the Proceedings of the American Gas Light Association, Vol. XVIII, page 77; in American Gas Light Journal, Vol. LXXV, page 807, or in Progressive Age, Vol. XIX, page 517. (Trustees.)

2. Has any conveyor been successfully applied to receive the hot coke as it comes from the retorts and transport it to the coke yard, the coke being quenched in transit? If so, give a description of it, illustrated with sketches.

Ans. As far as is known only one gas company in the United States has had, with conveyors for the transport of hot coke, a satisfactory experience that has extended over a period of several years, although there are several companies that have recently installed conveyors for the purpose named. Almost all of these recent installations are examples of types of conveyors that have been developed in Europe. The experience of the company first mentioned has been such that an improved

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form of the conveyor used in the old retort house has been installed in a new retort house recently built.

This conveyor consists of interlapping pans made from soft steel sheets $^3/_{16}$ in. thick. Each pan is about 15 in. long and by their interlapping they form a continuous trough 20 in. wide and 6 in. deep of the length required to serve the stack. To the bottom of each pan is fastened one link of a chain designed so that any link can be easily removed as occasion arises and so that the wear at the joints between the links will be very slight. This chain passes over a friction driving wheel set at one end of the run and is driven by the friction between this wheel and suitable cylindrical bearing pieces provided on the chain. The working run of the pan is supported by wheels with horizontal axles, turning in fixed bearings and set in pairs the proper distances apart, the whole length of the conveyor. To keep the wear caused by these wheels from coming on the pans themselves two narrow channel irons are riveted to the bottom of each pan, parallel to the driving chain and one on each side of it, and these channels form two continuous longitudinal grooves which rest on top of the wheels and serve also to guide the pan and keep it moving in a straight line. On the return the pan is guided by wheels with vertical axles, which bear lightly against the sides.

In this conveyor the coke simply rests in the pan and is carried along with it, so there is no fricton between the coke and the metal bottom. The chain is kept entirely out of contact with the coke, reducing the wear upon it, and being driven by a friction wheel instead of a sprocket wheel, slight increases in the length of link arising from wear do not interfere with the driving. The indivdual pans are very easily made by bending up the edges of flat plates of the proper size, and the parts upon which the wear comes can be very easily renewed, so that the conveyor is comparatively cheap in first cost and also in respect of cost of repairs. The Trustees have been unable to obtain sketches of this conveyor.

Almost all the other conveyors in use with hot coke act by pushing the coke along a fixed trough by means of scrapers

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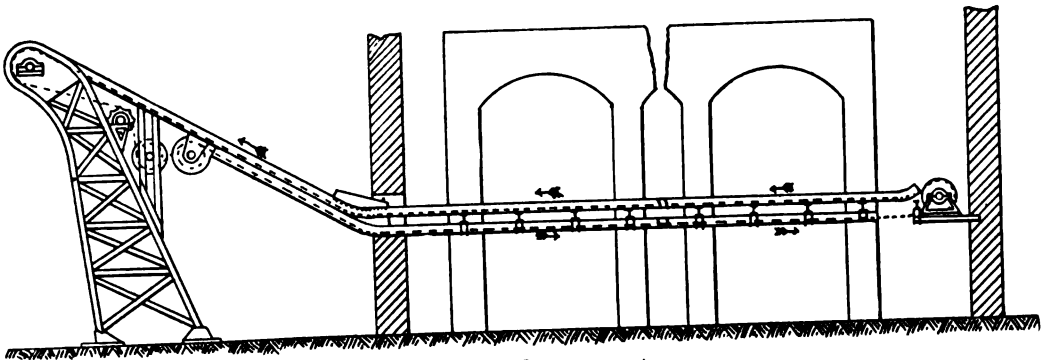
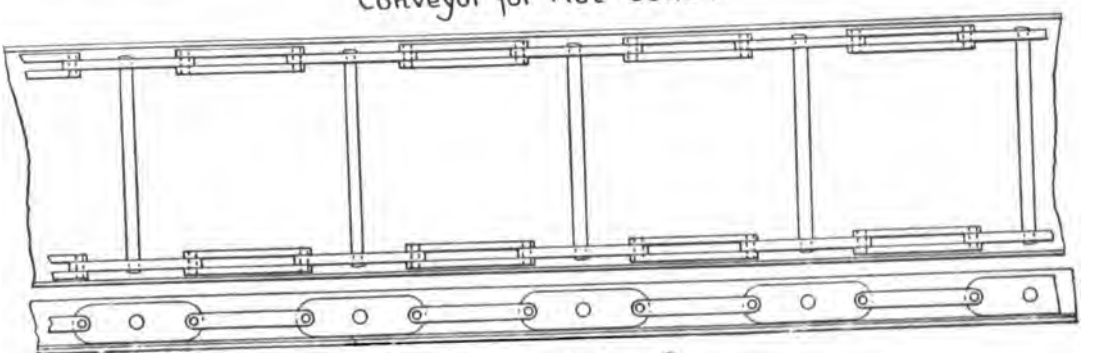


Outline of General Arrangement.

Conveyor for Hot Coke.



Detail of Chains and Cross Bars.

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of varying forms. The one that has been longest in use is illustrated on the accompanying cut, and consists of a trough made of cast iron, wrought iron, steel or masonry, in which move two endless chains of special construction joined together by cross bars at intervals of about two feet. These cross bars also act as distance pieces and keep the chains parallel. The trough is either placed on the charging floor of the retort house or set in this floor with its top flush with the floor level. It varies in width from 20 in. to 2 ft. 9 in., the largest size being used for large installations of inclined retorts. The depth is usually 5 in., though the wide troughs can be made with a depth of 3 in., since most of the coke falls near the centre and very little reaches the sides. The bottom of the trough must be perfectly smooth so that there shall be no obstruction to the moving coke. The joints between the various plates composing the bottom and between these plates and the angle iron sides must be made water-tight, and the ends of the trough are turned up to retain the water for quenching, which is run into the trough continuously while the conveyor is at work. At the end at which the coke is delivered the conveyor may be and usually is run up at an angle of 30° with the horizontal to a height sufficient to allow the coke to be piled or dumped into wagons or cars, as it has been found that the coke can be easily carried up a trough at this angle.

The chains, which are driven by suitable sprocket wheels, are kept as near the side of the trough as possible, so as to keep them away from the coke and thus reduce the wear and tear. As shown on the cut these chains are made of solid blocks joined together by links formed of two flat bars, one each side of the solid links. The weight of the chains and cross bars is carried by the solid links and therefore all the wear comes on these links, which slide on removable wearing strips fastened to the trough in such a way that they can be easily renewed. The links are also so riveted together as to permit of their being easily disconnected.

It would seem at first sight as if the round cross bars of comparatively small diameter would not be efficient in moving the coke along the trough. In practice, however, they are

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found to carry the coke along perfectly, imparting to it a sliding motion without turning it over or crushing it. Their use keeps down the weight of the moving parts and also the friction as compared with scraper or plate conveyors, and therefore this conveyor requires less power to do the same amount of work and there is less wear and tear on the bottom of the trough.

Another advantage claimed for it is that the return chain can be carried directly under the delivery trough, as shown, the total vertical space occupied being only from 8 to 10 inches.

When commencing work the trough is partly full of water throughout its whole length, but the coke as it moves along pushes the water before it until the inclined portion at the delivery end is reached. After being partly carried up the slope the water flows back over the coke and thoroughly quenches it. It is thus found that comparatively little steam is generated until the slope is reached, and by having this outside the retort house the steam is kept away from the stokers.

As stated, this conveyor seems to have been thoroughly tested, and in the opinion of European gas engineers of good reputation has proved successful.

For a more complete description of the second form described by the Trustees, and also descriptions of other forms, the students should read a paper on Coke Handling Plant, read before the Institution of Gas Engineers, and published in the Journal of Gas Lighting, Etc. (London), Volume LXXXIII, page 1349, and also in the American Gas Light Journal, Volume LXX, page 884. See also Journal of Gas Lighting, Etc. (London), Volume LXVIII, page 1235; Volume LXXI, page 1469; Volume LXXIV, page 767, and Progressive Age, Volume XVI, page 46. (Trustees.)

3. Give a description of a furnace and setting for horizontal return tubular boilers suited for the use of coke breeze as the boiler fuel, and state how you would obtain the draft required for the combustion of the fuel.

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Ans. Provided there is sufficient draft to overcome the greater resistance caused by the more compact nature of the fuel bed formed by gas coke breeze as compared with that formed by either coke or coal, breeze can be burned with fair economy in an ordinary horizontal return tubular boiler setting under natural draft. It is necessary to have a grate with openings small enough to prevent the breeze from falling through, and it is well not to have the grate too far below the boiler, say, from 2 ft. 0 in. to 2 ft. 6 in., since the breeze burns with a short flame and should be used in a thin bed. When the breeze is put in a little at a time and the fire kept thin and clean, fairly good results can be obtained with a furnace of this kind.

But natural draft is necessarily strongest on top of the fire and when a sufficient vacuum is maintained above a breeze fire to enable enough air to come through the fuel bed to produce the heat required to work the boiler up to its capacity, the products of combustion pass through the combustion space under the boiler and through the tubes at so high a speed that they pass into the chimney at a temperature too high for the greatest efficiency of evaporation. This high velocity of the products of combustion can be avoided by the use of forced draft, the resistance of the fuel bed being overcome by the pressure produced under it, while the conditions on top can be kept adjusted for the most economical working. The forced draft can be obtained either by the use of a fan blower or by means of a steam jet blower, and the current of air may be delivered into the closed ash pit of an ordinary setting, or through special, hollow, perforated grate bars. When a steam jet is used the steam is superheated by carrying the pipe through which it flows along the bottom of the boiler where it is exposed to the hot products of combustion. When a fan is used the air is often preheated by being made to pass through flues in the side walls and bridge wall.

A good form of steam jet blower installation is made by the Parsons Manufacturing Company. In this the steam pipe is carried along the bottom of the boiler to the back of the setting and the air is delivered from the back under the grate

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just in front of the bridge wall, through which the air pipe passes. The grate is made of iron plates perforated with a number of small holes.

The "White" grate is a type of the installations using a fan blower and hollow, perforated grate bars, the blast passing into the grate bars from a header with which they are connected.

Except for the special form of grate used and the provision of forced draft, the furnaces and settings are practically the same as those ordinarily employed for horizontal return tubular boilers. (Trustees.)

5. What are the arguments for and against Anti-dips?

Ans. The principal arguments in favor of the use of Anti-dips, or arrangements for doing away with the liquid seal on the dip pipes of coal-gas retorts while the retorts are closed and making gas, and either restoring this seal when the retort is out of use or open or else isolating the retorts at such times from the hydraulic or foul main by means of valves or other appliances, are that these Anti-dip arrangements prevent the excessive deposit of carbon in the retorts, that they improve the quality of the gas made, and that they lengthen the life of the retorts, other conditions remaining the same.

These advantages are supposed to spring chiefly from the fact that the removal of the seal allows the gas to flow out steadily and does away with the continual pulsations of pressure found in the retort when the gas has to force its way out through a liquid seal. "As the contact between the gases and the heated surface of the retort and its contents is the principal cause bringing about decomposition of the gas and vapor inside the retort, and, seeing that the effect of the seal is to cause the gases and vapors, from their elastic nature, to pulsate violently backward and forward along the roof and sides of the retort, it is evident that the gases and vapors traveling along the roof of the retort will be caused by this pulsating action to travel again and again over the same surface, and thereby be made to undergo repeated decompositions, and, consequently, an extra amount of carbon must be deposited." To test the

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truth of the theory thus stated by him, Mr. Young, of Clippens, Scotland, experimented with a retort fitted with a piston so that violent pulsations of the gas could be produced, and found that working under the same mean pressure and similar conditions as to heat, carbon deposited to a depth, in places, of ¾ in. during the six charges under pulsation, while when pulsation was avoided the deposit during the same number of charges was scarcely noticeable.

The more carbon deposited, over and above a certain amount derived from the decompositions necessary to produce fixed gas from the heavier vapors evolved during the earlier portion of the distillation, the lower the illuminating value of the gas. Further, with an Anti-dip arrangement in use, there is, of course, no danger of the gas having to bubble through tar and thus lose illuminating value.

The increased length of life of the retorts is considered to be due to the fact that the existence of a steady pressure in the retort allows the pores of the fire-clay to become thoroughly saturated with carbon which cements the particles of clay together, making the material stronger.

It is argued against Anti-dips that as generally made they are very liable to get out of order from the deposition of tar and pitch on the valve faces and seats and on moving parts, thus causing more expense through breakage, loss of time and loss of gas by leakage than is saved by the removal of the seal; that unless automatic in action they require constant thought in order to prevent loss of gas or occurrence of accidents from neglect to manipulate them properly; that the passing of the gas through the liquid forming the seal to the dip-pipe is a necessary and valuable step in purification; and in general that when proper precautions are taken to prevent the accumulation of tar and to maintain an even, regular liquor seal, the hydraulic main and the dip-pipe are among the most simple and useful of gas works appliances, and there is no occasion for dispensing with them in favor of even the most approved form of Anti-dip.

There can be no question, however, that Anti-dip arrangements are employed with good results in many works, espe-

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cially in Great Britain, and it seems as if on the whole the weight of evidence was in favor of their use when properly designed. (Trustees.)

6. What are the respective arguments in favor of the use of lime and iron oxide for purification?

Ans. It is argued in favor of the use of lime for purification, either alone or in combination with iron oxide, that as it removes from the gas a larger portion of the sulphur compounds than is taken out by oxide and all the carbon dioxide, for which the oxide has no affinity, the resulting gas is purer and of higher illuminating value than the same gas would be if purified by oxide alone, and will, moreover, burn with a whiter and more brilliant flame than can be obtained from a gas containing carbon dioxide, even though the loss of illuminating power due to the presence of the carbon dioxide is made up by the use of a larger quantity of enricher. These advantages it is claimed are fully worth the extra cost of lime purification over that of oxide purificaton, even when lime is comparatively expensive.

The advocates of the use of oxide of iron alone contend on the other hand that most of the gas coal used in America yields a gas containing such a small quantity of sulphur compounds, other than sulphuretted hydrogen, that there is no necessity for the removal of any portion of them, and that as usually employed in this country lime is no more effective than oxide in removing such compounds from gas. (Water gas contains even smaller amounts of these sulphur compounds than coal gas.) In contradiction to the statement that owing to the detrimental effect of the carbon dioxide, gas purified with oxide will have a lower illuminating value than the same gas would have had if purified with lime, it is claimed that careful comparisons of manufacturing results have shown that the change from lime purification to oxide purification does not cause any reduction in the illuminating value of the gas, other things being equal, owing to the fact that, as shown by analysis, the gas purified by oxide will contain a larger percentage of heavy hydrocarbons than similar gas purified by lime, and this

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extra amount of illuminants counterbalances the detrimental effect of the carbon dioxide.

It is also claimed that there is no noticeable difference between the flame produced by burning a gas containing the comparatively small percentage of carbon dioxide that would be found in a well made gas purified by iron oxide and that produced by a gas entirely free from carbon dioxide, the rate of combustion and the illuminating value of the gas being the same in both cases, and that, even if the illuminating value of gas purified by oxide should be slightly less than it would be if the carbon dioxide were removed by lime purification, the difference is so small that in most cases the cost of extra enrichment is much less than the extra cost of lime purification.

In other words, the advocates of purification by iron oxide alone, claim that there is practically no difference between gas purified by lime and that purified by oxide except that possibly the latter may show a slight loss in illuminating value, which can be made up at a cost much smaller than that of lime purification.

The use of a coal containing a large percentage of sulphur, and the existence of very stringent regulations as to the amount of sulphur allowed in the gas, may make the use of lime necessary for the removal of the sulphur compounds from the gas. (Trustees.)

7. Describe an arrangement by which the percentage of air admitted for continuous revivification of the oxide in the purifying boxes can be kept under control.

Ans. An arrangement for delivering a regulated amount of air for the continuous revivification of the oxide of iron in the purifying boxes that is simple and is coming largely into use consists of a small positive blower driven by a belt from a shaft of the exhauster used in pumping the gas from the retorts in the case of a coal gas works and from the relief holder in a carburetted water gas works. The respective capacities per revolution of the exhauster and the blower being known, the relation between the speed of the blower and that of the exhauster for any given percentage of air desired can be

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readily calculated, and the pulleys required to produce this relation placed upon the two shafts. When it is desired to make a change in the percentage of air being used it can be done by making the proper change in the size of the pulley on the blower shaft. When such an arrangement is first installed the accuracy obtained in the desired relation between the amount of gas passed by the exhauster and that of air furnished by the blower should be checked by passing the air through a meter and comparing the readings of this meter with those of the station meter, and this check by measurement of the air should be repeated at regular intervals so as to be certain that the desired percentage of air is being furnished. It will not be necessary, however, to take continuous measurements of the amount since the arrangement is sufficiently positive to be relied upon for the interval between checks. The air pipe should be provided either with a water seal or a check valve, which will prevent any gas from escaping when the exhauster is stopped for any reason, as when this occurs the blower will stop also, and if neither a seal nor check valve is provided gas will blow back out of the air pipe.

In a coal gas plant where there is a sufficiently high vacuum at the inlet of the exhauster, the air required can be drawn by means of this vacuum into the exhauster inlet through a safety seal and a dry meter. When this arrangement is adopted, the quantity of air that is being drawn in should be checked at frequent intervals by reading the station meter and the air meter and comparing these readings to see if the amount of air is the proper percentage of that of gas. If the percentage is not correct the necessary adjustment should be made on the stopcock with which the air pipe is provided. This method requires less apparatus than the one first described, but on the other hand it calls for a greater amount of supervision. (Trustees.)

8. Upon what property of illuminating gas does the amount of light that it will give per cubic foot when used in an incandescent burner depend?

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Ans. The authorities on the subject differ in their views as to the property of illuminating gas upon which depends the amount of light that it will give per cubic foot when used in an incandescent gas burner.

As a result of work done in connection with the Michigan Gas Association Scholarship in the University of Michigan, Messrs. White, Russell and Traver concluded that, other conditions being the same, the amount of light given per cubic foot by a gas when used in an incandescent gas burner was proportional to the calorific value and increased at the rate of one candle for each increase of four calories, or 15.87 B.t.u. in the calorific value per cubic foot. In their experiments they used an ordinary "C" Welsbach burner and a Welsbach mantle. The amount of gas as well as that of the air used with each gas was adjusted so that the maximum total amount of light was obtained, as they found that this condition corresponded with the maximum efficiency, that is, the giving of the maximum amount of light per cubic foot of gas consumed. The gases experimented with ranged from blue water gas to Pintsch oil gas.

After making a number of experiments with gases of different calorific values, the results of which were reported in 1903 to the International Commission on the Photometry of Incandescent Gas Burners, M. Saint-Claire Deville also reached the conclusion that the lighting effect produced by gas used in incandescent burners was, apart from differences in the mantle, proportional to the calorific value of the gas.

On the other hand, Dr. H. Bunte reported to the International Gas Congress held in Paris in 1900 that he had found that gases differing widely in their calorific value gave practically the same results when used in incandescent burners. In the experiments on the result of which the statement was based, the same burner was used without any adjustment either of air or gas, and as this burner was designed for use with a gas of comparatively low calorific value, it did not give for the gases of higher calorific value the results that can be obtained when they are burned under proper conditions, and, therefore, the conclusion of Dr. Bunte is hardly justified.

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Prof. V. B. Lewes holds that the flame temperature is of more importance than the calorific value of a gas in determining its efficiency in an incandescent burner, since the amount of light thrown off by any given incandescent material depends upon the temperature to which it is heated. On this basis the amount of air required for and the amount and character of the products formed by the combustion of the gas and the volume of the space in which the combustion of a unit volume of this gas is completed are as important as the calorific value. In the lectures in which he set forth these views Professor Lewes gives the results of experiments showing a duty of 19 to 20 candles per cubic foot from blue water gas when burned in a special form of Argand burner without any pre-admixture of air.

That the temperature of the incandescent body has an important influence upon the amount of light that it will give out is shown, among other things, by experiments made by Messrs. White, Russell and Traver, the results of which are given in the report mentioned above, and by the increased duty per cubic foot of gas which is obtained with the same gas and the same incandescent material by the use of high pressure and other forms of "intensified" incandescent burners. These burners differ from ordinary incandescent burners only in bringing about a better admixture of air and gas, and, by so doing, reducing the volume of the flame produced by the combustion of any given quantity of gas. It would, therefore, seem as if the flame temperature of a gas would influence its efficiency when used in incandescent burners and should be taken into consideration as well as the calorific value. There is, however, very little difference between the flame temperature of the different qualities of illuminating gas as ordinarily distributed, and the gases with the higher calorific values have also the higher flame temperatures. Moreover, the mantle never reaches either the theoretical or the actual temperature of the flame. Therefore, for practical purposes the efficiency of illuminating gas for use in incandescent burners may be taken as being proportional to its calorific value.

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The reports and lectures referred to above can be found as follows:

The Theory of the Incandescent Mantle, by White, Russell and Traver, American Gas Light Journal, Volume LXXVI, page 413.

Lighting Power of Incandescent Mantles, by Saint-Claire Deville, Journal of Gas Lighting, Volume LXXXIII, page 499.

The Future of Coal Gas and Allied Illuminants, Cantor Lectures delivered before the Society of Arts, by V. B. Lewes, American Gas Light Journal, Volume LXXVIII, page 5. (Trustees.)

9. Having taken charge of the engineering work of a gas company showing a large amount of unaccounted-for gas, how would you proceed to determine how much of this was due to actual loss from leaks in the mains and services and how much was due to other causes?

Ans. A large amount of unaccounted-for gas might be due, apart from actual leakage from the mains and services, to inaccurate registration of the amount passing through the station meter, to an excessive difference in the temperatures at which the gas is measured in the station meter and the consumers' meters respectively, to leaks in the holders, or to inaccurate registration by the consumers' meters owing to their being in bad condition. If much gas is used for street lighting, the use in the street lamps of more gas than is charged against them may also be an important factor in increasing the amount of unaccounted-for gas. It is, therefore, necessary to determine the extent to which any or all of the above named conditions exist before the amount of gas lost by actual leakage from the mains and services can be known.

The first step in the investigation would be to obtain accurate knowledge as to the temperature at which the gas is being measured in the station meter, and to apply the correction for volume necessary to obtain the measurement at the standard temperature suited to the locality. If no records are to be found of a recent reliable test the station meter should also be tested for accuracy of registration.

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In the meantime the holders should be examined for leaks, and any that are found should be stopped as far as possible.

The records of the consumers' meters should also be looked up, and if, owing to the absence of any regular system of periodical testing, the majority are found to have been left untested for five years or more, arrangements should be made to bring them in as rapidly as possible for testing and for such repairing as the testing shows to be necessary. At the same time a search should be made for any meters that may be set and using gas without the record of their location showing on the books of the company. This, however, is only necessary when the records are in such poor shape that it seems probable that meters may have been set and not entered on the records, or may have been left out when transferring the records from one book into another.

The character and condition of the street lamp burners should be examined into, as well as the pressure conditions obtaining in the different sections of the town during the hours when the lamps are lighted. If the lamp burners are supposed to be using four or five cubic feet per hour, and the conditions are such that they are actually using eight to ten cubic feet, the extra consumption will materially increase the amount of unaccounted-for gas. This cause is sometimes sufficient to account for an apparent loss of four or five per cent. of the gas made. It can be remedied by the use of either governor burners or checked burners suited to the conditions of pressure under which the gas is to be burned.

If the loss of gas still continues high after all these possible causes of a large amount of unaccounted-for gas have been investigated, and any of them that may have been at work to bring up the amount have been corrected, it will be necessary to charge the loss to actual leaks from the mains and services, and their condition should be examined into without delay. (Trustees.)

10. Describe a method of filing and reporting upon orders for setting and removing meters which makes it certain that all such orders are properly attended to and that the changes of

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meters made in carrying them out are properly recorded. Include in your answer the system of checks necessary in order that the reading of all meters set and removed may be correctly made and recorded.

Ans. The system to be described will be applicable to a works of the largest size. Portions of the system may be shortened or altered without impairing its effectiveness.

The orders to set, change, and remove meters are issued by the Commercial Department, that is, the department which keeps the ledgers, collects the bills, etc.

The reasons for such orders are as follows:

1. Set card, when a consumer signs an application for gas.

2. Remove card, when a consumer ceases to use gas and it is the policy of the company to remove the meter, instead of merely shutting it off.

3. Change card, when the meter in use leaks, registers incorrectly, or is in any other way defective, or when a change in the type or size of the meter is desired. A large number of the change cards would therefore of necessity be originated by the Distribution Department, which attends to the complaints; but they should, in all cases, be issued by the Commercial Department for reasons which will be explained.

It is absolutely essential that a completed meter card reach the Commercial Department in order that the index may be posted in the consumers' ledger. To insure this, all the cards are issued by that department, and a check held against the order until its completion. To facilitate this, the cards are printed in duplicate as per forms shown.

Considering first the Set Card, Form 1, the Commercial Department, on receiving an application, folds the card at the middle line and inserts a carbon sheet between the original and duplicate. The name and address of the consumer is then written on, and the original and duplicate stamped with the same number, and the two torn apart. The duplicate is filed geographically, and the original sent to the Distribution Department.

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In order that the last-named department may keep track of the set card during the execution of the work, the information on it is entered on the history card, Form 4, bearing the same address as the set card, this history card being one of a complete set of such cards (one for each house, *i. e.*, each system of house piping for which a meter has ever been set) filed geographically. The entry would show that a set card had been issued and was in process of completion for that particular house.

The set card would be handed to a workman to complete, and theoretically both the card and the meter which he would draw from the stock to set, should be charged against him. It has been found in practice, however, that with an efficient checking system, with regard to the card, the charging of the card to the man may be omitted. The meters, however, are charged up by number, index, and size on a sheet which is kept in the office. On setting the meter, the workman fills up the blank spaces indicated, giving the meter index and the Company's number (the size having been determined and entered in the office), and signs his name with date. On returning the cards to the shop, the cards and any unused meters returned must balance the meters on the sheet. Any discrepancies would be shown and checked at once.

To check the index of the meter that has been set, the set card is compared with the stock card carried in the district shops of the Distribution Department. This stock card is made out whenever a meter is received in the district shop, either from a consumer by removal, or from the meter repair shop in a consignment of new or repaired meters. It contains simply the Company's number, size and index. To insure its accuracy, it is checked in the following manner: The consignment of meters from the Meter Repair Shop to the district shop is accompanied by a shipping slip, containing the Company's number, size and index. On receipt of the meters the stock card is made from each meter direct. These cards are then compared with the shipping slip, and, as can be readily seen, this double-checks the description of the meter. This

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Form 1

DISTRICT	REGISTER No.	METER ORDER No.
THIRD		6871

SET

THIRD DISTRICT JAN. 16 1903

LOCATION 1260 W. Market

NAME Chas. Smith

N. OF O. New Set

Ledger Name _____

Comp. Ledger

Folio

By

Co's No. 26781

Size 5

Index 264

Set by J. Brown

Date 1-23-03

Moved from N. Y.

Remarks Set on Jan. 23

Loc. Book No. ____ Page ____ Folio ____ Line ____

Comp. Led.

Route Book ____

Loc. Book Folio ____

Addgh. ____

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Form 1

DISTRICT	REGISTER No.	METER ORDER No.	SET
THIRD		8671	THIRD DISTRICT JAN. 16 1903

LOCATION 1260 W. Market

NAME Chas. Smith

N. OF O. New Set

DUPLICATE

Original and Duplicate will receive the same "Meter Order Number." Dispatcher will send Original to Shop. This Duplicate will be placed in geographical file of "Duplicate Orders Unattended To"; from which it will be removed when Original Order has been returned from Shop and entered in Meter Location Book This Duplicate will then be placed in serial file, and after accounting to the Superintendent of Meters for orders issued, to be destroyed.

BURNERS IN HOUSE

SIZE SERVICE

REMARKS

REPORT

Form 2

DISTRICT	NOTICE TO SHUT OFF	METER ORDER No.	REMOVE
THIRD		62598	THIRD DISTRICT SEPT. 26 1903

LOCATION 1260 W. Market

NAME Chas. Smith

CAUSE Consumer moved

Ledger Name _____ Comp. Ledger 9/26 Folio 21 By M. J.

Co's No. 103362	Key at House open	Loc. Book No.
Size 5	Moved to N. Y.	Page
Index 359		Cons. Led. Folio
Removed by J. Brown	Send bill to Same	Line
Date Sept 28. '03		Route Book
	Gas on ..... Gas off	L. B. Fol.

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Form 2

DISTRICT	NOTICE TO SHUT OFF	METER ORDER No.
THIRD		62598

REMOVE

THIRD DISTRICT SEPT. 26 1903

LOCATION 1260 W. Market

NAME Chas. Smith

CAUSE Consumer moved

DUPLICATE

Original and Duplicate will receive the same "Meter Order Number." Dispatcher will send Original to Shop. This Duplicate will be placed in geographical file of "Duplicate Orders Unattended To"; from which it will be removed when Original Order has been returned from Shop and entered in Meter Location Book. This Duplicate will then be placed in serial file, and, after accounting to the Superintendent of Meters for orders issued, to be destroyed.

BURNERS IN HOUSE

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stock record is purely a live file, that is, each card represents a meter in stock in the district shop.

When a meter is set the particular card is lifted as described above, and it is perfectly safe to say that if the description on the set card tallies with the description on the stock card, the reading is correct.

In order that a daily record and balance of meters can be kept, each meter set or removed is entered in a Set and Remove Book, which shows the Company's number, size (each in its own column), house number and index. For a meter set, this entry could be made from the meter card, and the stock card compared with the entry. For a meter removed, when the meter is brought in, the stock card is made out from the meter and the entry of the meter in the Set and Remove Book, made directly from the remove card. Comparing the stock card with this entry would then be a thorough check.

Having checked and recorded the index and description, the fact that the set has been completed is entered on the history card. Form 4 shows the arrangement of the history card. The arrangement of the meter record at the top is self-explanatory. Under "history," the entry of the order number, date received, and "New Set," or "Change Water," or "Remove Consumer Moved," to the point "A," would be made when the card is first received by the Distribution Department; the balance when the card is completed. The entry under the O. K. column can be made in red, so that it can be told at a glance whether all orders for the particular house are completed. The system described for the set card applies equally to the remove and to the change card, the latter being a combination of the set and remove.

The full entry on the history card having been made, the card is returned to the Commercial Department. Here the index is entered in the ledgers and the card transmitted to the Meter Repair Shop, where the description is entered on the meter record card described in the answer to Question No. 9 of the Eleventh Series of Questions. By keeping the numbers of all meter order cards consecutive, the meter repair shop,

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by filing the cards numerically, can determine if there are any omissions, and thus any permanent loss of an order card will be known.

The duplicate held in the Commercial Department as a check is destroyed upon the return of the original from the Distribution Department.

It will be noted that Forms 1, 2 and 3 are printed on both sides, the back of the card being used by the fitter to make reports when he is unable to complete the work, or to add any additional information. This will be clear by referring to the reverse side of the change card, these cards being filled out complete, and also entered on the history card. An examination and comparison will render the scheme clear.

The question as to the correct reading of a meter when set or removed, often arises after the reading has been changed either through use or repair of the meter. It is quite important in such cases, involving, as they do, a difference of opinion between the consumer and the Company, that the latter has in its possession sufficient evidence to assure the correctness of the reading on its own books. For convenience, the evidence in each case will be shown below, though some of it will be a repetition of what has been written above.

To check the correctness of the reading on a set card, we have,

1. The reading shown on the shipping slip from the meter repair shop, or, if the meter has been proved in the districts, the entry of the index in the proving record book.

2. The entry in the set and remove book.

3. The entry on the history card.

4. If the meter had been previously in use at another location, and removed and proved without altering its index, the removal record could be referred to. The necessity of this would scarcely ever arise.

To check a remove card, we have,

1. The entry of the index in the meter-proving book.

2. The entry in the set and remove book.

3. The entry on the history card.

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Form 3

DISTRICT	WHY CHANGED?	METER ORDER No.
THIRD	WATER	21202

CHANGE

THIRD DISTRICT MAR. 24 1903

LOCATION 1260 W. Market

NAME Chas. Smith

Ledger Name _____ Comp. Ledger 3/24 Folio 21 By J. J).

	METER SET.	METER REMOVED.	WHERE	REM.	SET.
Co's No.	103362	26781	Sid. Map No.		
Size	5	5	Sid. Page		
Index	0	342	Sid. Folio		
Chg'd by	S. Robinson	Shop	Sid. Line		
Date	3-26-03		Route Bk.		
			L. B. Fol.		

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Form 3

DISTRICT	WHY CHANGED ?	METER ORDER No.
THIRD	WATER	21202

CHANGE

THIRD DISTRICT MAR. 24 1903

LOCATION 1260 W. Market

NAME Chas. Smith

Company's No. Meter Removed 26781

Authority for Order

DUPLICATE

Original and Duplicate will receive the same "Meter Order Number." Dispatcher will send Original to Shop. This Duplicate will be placed in geographical file of "Duplicate Orders Unattended To"; from which it will be removed when Original Order has been returned from Shop and entered in Meter Location Book. This Duplicate will then be placed in serial file, and, after accounting to the Superintendent of Meters for orders issued, to be destroyed.

BURNERS IN HOUSE

SIZE SERVICE

REMARKS

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Using gas all 3/26

S. Robinson 3/25

Form 4. CONSUMER'S RECORD CARD.

1260 W. Market ST. 1st Floor

METER		SET			REMOVED			SERVICE	
								SIZE	DATE
GDFG NO.	SIZE	ORDER NO.	DATE	INDEX	ORDER NO.	DATE	INDEX		
26781	5	6871	1/22/03	264	21202	3/26	342		
103362	5	21202	3/25	0	62398	9/28	359		

House Pipe Inspection	
NO.	DATE
1	
2	
3	
No. of Burners	
Stove Line	
SIZE / LENGTH	DATE

ORDER NO.	KIND OF ORDER	DATE REC'D	HISTORY	O. K.
6781	St.	1903 1/16	*New Set ↑ Set 5 lt. meter, first*	
			floor only. J. Brown 1/23	*O. K.*
27851	O	3/24	*Insufficient ↑ Found water in 5 lt.*	
			meter, emptied same. Meter should	
			be changed. Ind. 328	
			F. Jenks 3/24	*O. K.*
21202	Ch	3/24	*Change water ↑ Using gas. Call 3/26*	
			Ind. 340. S. Robinson 3/25. Changed	
			5 lt. meter. S. Robinson 3/26	*O. K.*
62398	R	9/26	*Rem. Consumer moved ↑ Removed*	
			5 lt. meter. J. Brown 9/28	*O. K.*

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CONSUMER'S RECORD CARD.

ORDER NO.	NUMBER OF ORDER	DATE RECD.	HISTORY	O. K.

4. The entry on the shipping slip if the meter is sent away for repairs after removal, or the record of the set, if it did not need repairing and has been again set before the question of error arises.

The change card being a combination of the set and remove, the above applies equally well to it. (Trustees.)

11. The inventor of a patent process of making gas claims that it uses only 12 lb. of bituminous coal and 2.4 gallons of Ohio crude oil per 1,000 cubic feet of gas made, and that the gas has a calorific value of 502 B.t.u. per cubic foot. How can it be shown that the above claim is impossible of realization?

Ans. When wonderful working results are claimed for a process it is always well to test the possibility of securing these results by applying the principle of the conservation of energy and determining whether or not the quantity of materials said to be used is capable of supplying the energy which it is claimed exists in the products. In doing this it must be borne in mind that no process for making gas from solid or liquid bodies can have a thermal efficiency of 100%, since some heat is required to overcome the attraction between the molecules of solid and liquid substances and convert them into gases, and also since it is impossible to avoid losses of heat by radiation and the sensible heat of the escaping waste products. The thermal efficiencies of the commonly employed processes for making gas vary from about 50% to about 80%.

In the absence of any specific information as to the calorific values of the coal and oil used, it will be safe to assume that they are not greater than 14,000 B.t.u. per pound for the coal and 19,800 B.t.u. per pound for the oil. The specific gravity of Ohio crude oil is about 0.83, and therefore a gallon will weigh 6.99 lb. The weight of materials used per 1,000 cubic feet, according to the claims of the inventor, will thus be 12 lb. of coal and 16.78 lb. of crude oil. The quantity of heat that can be produced from this amount of coal and oil is $12 \times 14{,}000 + 16.78 \times 19{,}800 = 168{,}000 + 332{,}250 = 500{,}250$ B.t.u. The

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calorific value claimed for the gas made is therefore greater by 1,750 heat units than the total amount of heat in the materials employed, and the claim is manifestly impossible of realization. (Trustees.)

FIRST SERIES OF QUESTIONS—SECTION OF 1910—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. What is coal gas? What is water gas? What is carburetted water gas? What is oil gas? What is the average composition of each kind of gas?

2. What are the properties that must be possessed by a coal to fit it for being used for the manufacture of coal gas?

3. Name the chief impurities in crude coal gas as it leaves the retorts, and give the reasons why they should be removed from the gas before it is distributed.

4. Name the useful by-products or residuals produced in addition to the gas in the manufacture of coal gas. In the manufacture of carburetted water gas.

5. Name the principal pieces of apparatus necessary in a coal gas works, and state briefly the function of each.

6. Name the principal pieces of apparatus necessary in a carburetted water gas works, and state briefly the function of each.

7. What does the ordinary U or syphon gauge indicate, and what is the object of its use in gas works?

8. How does a suction pump "draw" water? Why and how does a hot chimney "draw"?

9. Why is it necessary to provide for draining all mains and pipes through which gas travels, and how is this done?

10. What is the commonly accepted theory as to the cause of the luminosity of the flame produced by burning illuminating gas in a luminous burner?

11. Why is the flame of a Bunsen or atmospheric burner non-luminous?

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12. What is common lime and what is the raw material used in its manufacture? What is hydraulic lime and what is the raw material used in its manufacture? What is hydraulic cement and what is the raw material used in the manufacture of natural hydraulic cement?

(Answers to these questions are due March 1, 1907.)

Answers to First Series of Questions — Section of 1910 — Practical Class — Trustees Gas Educational Fund.

Answers to all of these questions have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 1, Vol. I., page 213.
No. 2, Vol. I., page 214.
No. 3, Vol. I., page 215.
No. 4, Vol. I., page 215.
No. 5, Vol. I., page 216.
No. 6, Vol. I., page 216.
No. 7, Vol. I., page 217.
No. 8, Vol. I., page 218.
No. 9, Vol. I., page 219.
No. 10, Vol. I., page 220.
No. 11, Vol. I., page 221.
No. 12, Vol. I., page 221.

Fifth Series of Questions—Section of 1909—Practical Class—Trustees Gas Educational Fund.

1. What are the respective advantages and disadvantages of anthracite coal, gas coke and furnace coke when considered with reference to their use as the fuel in the generator of a carburetted water gas apparatus?

2. After having heated up and put into regular operation a bench of retorts, full depth regenerative setting, how would you proceed to adjust the chimney dampers and primary and

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secondary air slides in order to secure the greatest fuel economy?

3. Give a description, illustrated with sketches, of one or more forms of scrubbers used for removing ammonia from coal gas. If you are not familiar with coal gas apparatus, describe, and sketch, the so-called scrubber used in connection with a carburetted water gas plant.

4. The answer to Question No. 4, Fourth Series, states that the speed of an exhauster in a coal gas plant should be governed in such a way as to be increased when the rate at which gas is made increases, and to be decreased when the rate at which gas is made decreases. Give a description, illustrated with sketches, of one or more forms of governor that will automatically regulate the speed of an exhauster according to these requirements.

5. What is meant by the heating power, or calorific value, of a substance? How is the heating power of a substance determined?

6. What is the effect of heat upon the volume of any given weight or quantity of gas, and what bearing has this effect upon the question of the measurement of gas?

7. How much pure ammonia gas (NH_3) is contained in a gallon of ammoniacal liquor which has a strength of 7 oz?

8. What is the minimum size of pipe which it is considered advisable to use for services for ordinary dwelling houses? Give the reasons for your answer.

9. Flat flame burners are of two kinds, known respectively as fishtail and batswing burners. Give a description of each kind, and state which will give the greatest amount of light from a given illuminating gas, the gas being consumed under the proper conditions to give the best result in each case.

10. Give a description, illustrated with sketches, of one or more forms of circulating gas water heaters for use in connection with ordinary kitchen boilers.

11. What is meant by the term "light" used in designating the size of meters? Is the capacity per "light" the same in

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small meters, such as 3-lights, as in large meters, such as 100-lights?

12. What are the relative advantages of brick and stone masonry for building construction?

(Answers to these questions are due April 1, 1907.)

Answers to Fifth Series of Questions — Section of 1909 — Practical Class — Trustees Gas Educational Fund.

An answer to question No. 4 has already been published in Vol. I. of the Proceedings, and can be found there on page 155. An answer to a question which is the same as question No. 7, except for the figures, can be found on page 138 of Vol. I. The answers to the other questions are as follows:

1. What are the respective advantages and disadvantages of anthracite coal, gas coke, and furnace coke when considered with reference to their use as the fuel in the generator of a carburetted water gas apparatus?

Ans. Anthracite coal will contain less ash than gas coke and will therefore make less clinker than such coke. Since it is much denser than coke a given generator volume will hold a greater weight of fuel when coal is used, and this fuel will neither heat up nor lose its heat as rapidly as coke. This permits of longer "runs" and "blows" and so reduces the percentage borne by the time required for opening and closing the valves in putting on and taking off the runs, to the total time during which the machine is in operation. With coal there is also the further advantage that the generator does not have to be opened as often for charging as is necessary with coke.

On the other hand the surface presented to the action of the blast and steam is smaller with anthracite coal than it is with gas coke, owing to the porous nature of the latter. The irregular form and roughness of the surface of the individual pieces of coke keep the fuel bed in a condition favorable for the general and intimate contact of both blast and steam with the

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carbon of the fuel. The heat can therefore be gotten up quickly and gas made at a rapid rate during the shorter run, and with quick workmen the increase of time required for handling the valves owing to the shortness of the blows and runs is not of great importance. It is, however, necessary when using gas coke to be very careful not to unduly prolong either the blows or the runs, since, owing to the rapidity with which coke is consumed, any over blowing increases the fuel account very greatly, while any extra length of run increases the amount of carbon dioxide in the gas very rapidly, since the fire cools off quickly.

In general it is probably true that fair results as to the quantity of fuel used per 1,000 cubic feet of gas and the quality of the gas made can be secured more easily with coal than with gas coke, but that given good management and the necessary supervision to ensure the proper handling of each kind of fuel there is little, if any, choice between the two materials.

Furnace or oven coke, unless it is made from carefully washed coal, or from coal that is originally free from ash, such as that used in making Connellsville coke, is apt to contain more ash than gas coke and to give trouble from clinker. It does not possess the density of anthracite coal nor is it as porous as gas coke. The 48-hour or soft coke makes a better generator fuel than does the 72-hour or hard coke. Opinions differ as to the relative merits of furnace coke and gas coke, some engineers preferring gas coke, and others furnace coke under similar conditions.

Given the proper handling of each, there is, however, little difference between the three classes of fuel, and even slight differences in prices or in local conditions will be sufficient to turn the scale in favor of one or the other. (Trustees.)

2. After having heated up and put into regular operation a bench of retorts full depth regenerative setting, how would you proceed to adjust the chimney dampers and primary and secondary air slides in order to secure the greatest fuel economy?

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Ans. When a bench of retorts with a full depth regenerative setting has been heated up to the required heat and put into regular operation the proper conditions for economical running are obtained as follows: The chimney dampers are pushed in, until, on opening the charging door of the furnace and throwing into the fire a handful of coal dust, the resulting flame plays lazily back and forth out of the door, being neither drawn steadily in by the draft nor forced out too vigorously by an excess of pressure. If the heat can be maintained with a slight pressure on the furnace great economy of fuel can be attained, but, as a rule, heats cannot be kept up unless the pressure is cut down practically to zero. There should never be a decided "pull" on the furnace except on special occasions, when the heat has to be brought up quickly, without regard to the quantity of fuel used. The dampers set, the heat is brought to the proper point by increasing or decreasing the primary air opening, the secondary air being kept properly proportioned to the amount of carbon monoxide produced by the furnace. The proper amount of secondary air opening is determined by noting the disappearance in the take-off flue, or at any convenient point of observation in the waste gas flues of the recuperators where the heat is not too high, of the blue flame that indicates the escape of unconsumed carbon monoxide from the combustion chamber. If this flame is present the secondary air opening is gradually increased until the flame disappears, waiting a sufficient length of time after each slight increase of opening for the extra air to travel through the bench. When the flame is gone, the adjustment is right and the secondary air slides should be clamped. If no flame is present and the adjustment has not been made for some time, the secondary air openings are decreased until the flame appears, and then the adjustment is made as above. As the quantity of carbon monoxide produced varies with the condition of the fire as to the amount of ashes, depth of fuel-bed, etc., the secondary air supply cannot be kept exactly right for every hour of the day, and this being so, enough is supplied to consume the average maximum production of carbon monoxide, since the loss of heat due to the small excess of secondary air present, when

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less carbon monoxide is made, is smaller than would be suffered by allowing an equal quantity of carbon monoxide to escape unconsumed, the loss of sensible heat being practically equal in both cases, while with the unconsumed carbon monoxide there is the additional loss of its heat producing power. If there is sufficient recuperating surface in the bench, the appearance in the recuperators below the point of entrance of the secondary air of any heat above a dark red is an almost certain indication of an insufficient secondary air supply, even though no flame can be seen, the flame not being very marked in a highly heated space.

After this adjustment of the damper and air slides is made, they are fastened so securely that it is impossible for them to be moved unintentionally.

Regenerative benches will not give the best results, nor the highest heats, unless the adjustments spoken of above are properly made, and the making of them should not be left entirely to the average retort house fireman, nor even to the average foreman, until he is taught enough of the principles of generator firing to have some insight into what he is trying to do. Even then regular investigation by the superintendent of the conditions of damper opening and air supply will tend to keep down the percentage of fuel used.

If the works is equipped with a gas analysis apparatus and an employee who is enough of a chemist to be able to obtain accurate results with this apparatus, the supply of secondary air can be regulated by means of analyses of the waste gases more closely than by the method described above. The latter will, however, give results that will be as good as, and probably even better, than those obtained from analyses that are improperly or carelessly made. (Trustees.)

3. Give a description, illustrated with sketches, of one or more forms of scrubbers used for removing ammonia from coal gas. If you are not familiar with coal gas apparatus, describe, and sketch, the so-called scrubber used in connection with a carburetted water gas plant.

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Ans. The scrubbers first employed in the manufacture of coal gas were of the well-known tower type, which in this country is still largely used in small works. These scrubbers consist of a shell of wrought or cast iron, either square or cylindrical, and ranging from 12 ft. to 60 ft. in height, the diameter being $1/4$ to $1/5$ the height. This shell is filled with some material which is of such a nature, and is so placed, as to form numerous narrow channels, in travelling through which the gas, which enters at the bottom and leaves at the top of the scrubber, is forced to pass over a large area of surface wet by water supplied in a suitable quantity and distributed over the top of the filling material in such a way that as it trickles down through this material all of the surfaces presented to the gas are kept thoroughly and uniformly wet. The proper distribution of the water over the material without the use of so much water as to make the resulting ammoniacal liquor very weak is one of the most difficult problems in connection with the working of tower scrubbers.

As usually built in this country at the present time these scrubbers have cylindrical wrought iron or steel shells, 3 ft. to 6 ft. in diameter and 12 ft. to 20 ft. high, and are filled with bundles of thin boards on edge, the boards being from $3/8$ in. to $1/2$ in. thick and 6 in. to 9 in. high and the bundles being made up with $1/2$ in. spaces between the boards and of a length and width suited to the diameter of the scrubber to be filled. These bundles are built up tier by tier, each tier resting on, and being laid with the boards at right angles to, those in the tier below. At proper intervals in the height of the scrubber, supports are provided so that space can be kept between the adjacent tiers of boards in order to permit of a redistribution of the gas and also provide for the removal of one set of bundles, if necessary, without disturbing the others. Various methods are employed to secure a uniform distribution of the water. One is to force the water in a single jet through a nozzle opening upward in the centre of the scrubber and cause it to strike against a metal disc placed a few inches above the nozzle and thus to be broken up into a spray which falls very uniformly over the whole surface of the top tier of boards. Another is to allow the water to

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trickle through a number of small perforations made in pipes, which are inserted radially through the sides of the scrubber immediately beneath the top plate. Provision is made for the easy removal of these pipes to permit the examination of the perforations, and their cleaning in case they become clogged.

In larger works the tower scrubber has been almost superseded by some form of the more modern rotary or mechanical scrubber. One form of rotary scrubber is illustrated on the accompanying cuts. The shell is of cast iron, and in shape is a rectangular prism surmounted by a half cylinder. It is divided

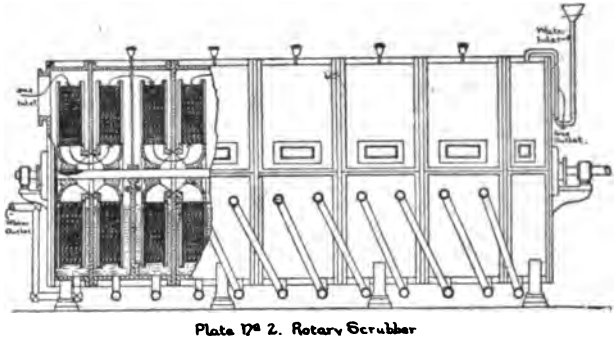

Plate 17a 2. Rotary Scrubber

into a number of compartments by means of plates at right angles to its axis, one set of these plates being the full size of the cross section of the shell and having circular openings, the centres of which are on the axis of the half cylinder, while those of an alternate set extend from the bottom to the top of the prism only. The shell is traversed lengthwise by a shaft, the axis of which coincides with the axis of the cylindrical portion, and which is supported by suitable bearings on the end plates and on the second set of cross plates mentioned above. On the shaft are fastened annular bundles of wooden slats, there being one bundle for each compartment of the shell, built up so that the gas can travel between the slats from outer to inner circumference of the bundles or vice versa, but not straight across the bundles parallel to the shaft. The central openings of the bundles are alternately closed and open in such a manner in conjunction with the arrangement of the cross plates that, when the scrubber is filled with water to the proper

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level, the gas is forced to travel through the upper half of the bundles from circumference to centre, and from centre to circumference, alternately, as shown by the arrows.

Means, consisting usually of a small engine and the necessary train of gearing, are provided to slowly rotate the shaft and attached bundles. The spaces between the slats are very narrow and thus the gas in passing through the scrubber flows in thin streams over surfaces kept continually wet by dipping into the liquor in the lower part of the shell as the shaft rotates. Water is admitted to the end opposite to that at which the gas enters and is carried by suitable overflows from one compartment to another until it finally leaves the scrubber at the gas inlet end. In this way the foul gas is caused to come in contact first with the strongest liquor, and then as it passes through the scrubber and its contents of ammonia decreases, with liquor of decreasing strength until, the ammonia having been all extracted, clean gas only enters the last compartment, which thus contains pure water.

Since these scrubbers are made with a comparatively large number of compartments it is possible to keep more than one clean and thus run no risk of losing any ammonia, and at the same time have sufficient scrubbing capacity to use only a small quantity of water and produce a correspondingly strong ammoniacal liquor. (Trustees.)

5. What is meant by the heating power, or calorific value, of a substance? How is the heating power of a substance determined?

Ans. By the calorific or heating value of a fuel is meant the total number of heat units that are developed by the complete oxidation of all the combustible materials contained in unit weight or unit volume of the fuel.

In the case of gases the calorific value is ordinarily expressed in heat units per cubic foot. Thus hydrogen has a heating value of 326.2 B.t.u. (British thermal units) per cubic foot. In other words, the heat developed by the complete oxidation or burning of one cubic foot of hydrogen to water

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is equal to that necessary to raise 326.2 lb. of water 1° F. from its temperature of greatest density, 39.1° F.

In the case of liquids and solids the heating value is expressed in heat units per pound. Thus carbon has a heating value of 14,544 B.t.u. per pound when burned completely to carbon dioxide (CO_2).

In the case of hydrogen and substances which contain hydrogen as one of their constituents, a distinction must be made between the gross or total heating power and the net or available heating power. The complete combustion of such substances produces water, which, while it is liquid at ordinary atmospheric temperatures, is a vapor at the temperatures at which the products of combustion escape under the ordinary conditions of the combustion of gases. To convert a pound of water from the liquid state to that of vapor at 212° F. 966 heat units are required. Since each pound of hydrogen burns to 9 lb. of water there will be a difference for each pound of hydrogen contained in the combustible gas of $9 \times 966 = 8{,}694$ heat units plus the number of heat units given out by 9 lb. of water in cooling from a temperature of 212° F. to that at which the condensed water leaves the apparatus between the total heat of combustion as estimated by a calorimeter, in which the water is condensed to the liquid form and the heat required to vaporize it set free and measured, and the net heat or heat available, when, as in ordinary combustion, the water escapes in the form of vapor. If the temperature of the products of combustion is reduced to 60° F. by the calorimeter, the amount of heat given off by the water produced from 1 lb. of hydrogen will be approximately $(212-60) \times 9 = 152 \times 9 = 1{,}368$ heat units, and the difference between the gross and the net heating value of 1 lb. of hydrogen will be $8{,}694 + 1{,}368 = 10{,}062$ heat units. If, however, the total heating power of hydrogen, as determined by the calorimeter, is 62,100 heat units, the net heating power, when the water escapes in the form of vapor at 212° F., will be $62{,}100 - 10{,}062 = 52{,}038$ heat units, and the net heating value per cubic foot will be 275 heat units. In the same way, knowing the percentage of hydrogen contained in

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any substance, the net heating value can be obtained by making the proper deduction from the gross value.

The calorific value of an elementary substance such as carbon or hydrogen can be obtained only by experiment. In making such determinations, an instrument called the calorimeter is used. This is so arranged that the heat produced by the combustion of a known weight, or volume, of the substance is imparted without any loss to a known weight of water. By observing the temperature of the water both before and after the combustion has taken place, the extent to which the water has been heated is determined and the heat absorbed by the water, which is necessarily that produced by the combustion, can then be easily calculated. The instrument must be so designed and handled that no loss of heat takes place, or at least so that any heat that is not accounted for is an inappreciable percentage of the total.

In the case of a compound substance the calorific value can either be obtained by experiment or, with more or less accuracy, by calculation. When the substance is a gas and an accurate analysis is available the calorific value can be obtained very accurately from the calorific values of its combustible constituents and the percentage in which each is present. When the substance is in the solid or the liquid state any determination of the calorific value made by calculation is approximate only, since so far it has been found impossible to determine exactly the effect produced upon the calorific value of a gas by the entrance of this gas into a compound which exists as a solid, or a liquid. Various formulas have been worked out for the calculation of the calorific values of different kinds of coal, for instance, from their chemical composition; but these formulas, while they may fit the particular samples of coal used in the experiments from which they are worked out, do not give accurate results when applied to other samples. It is therefore more accurate to determine the calorific value of compound substances in a solid state or a liquid state by calorimeter tests than by calculation. This is also true of gaseous substances when, as is usual in the case of illuminating gas, the exact composition is not shown by the analysis, there being grouped

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together in one item several substances giving similar chemical reactions but possessing widely differing calorific values. (Trustees.)

6. What is the effect of heat upon the volume of any given weight or quantity of gas, and what bearing has this effect upon the question of the measurement of gas?

Ans. The volume of a given weight of gas, that is, the space occupied by the quantity of gas possessing this weight, is increased when the temperature of the gas increases, and is decreased when the temperature decreases. It has been found by careful and accurate measurement that the exact amount of this increase or decrease is $^1/_{273}$ part of the volume of the gas at 0° C. for each change of 1° C. in the temperature. This is equivalent to an increase of $\frac{1}{273 \times 1.8} = \frac{1}{491.4}$ (or as it is usually taken $^1/_{492}$) part of the volume at 32° F. for each change of 1° F. in the temperature of the gas. The rule is sometimes given approximately as being, that the volume increases 1% of the original volume for each increase of 5° F. in the temperature, the original volume being measured at the temperature, whatever it may be, that it may happen to possess. But for accurate work it is necessary to remember that the increase in volume for an increase in temperature of 1° F. is not the $\frac{1}{491.4}$ part of the volume at any temperature, but only that part of the volume at 32° F. It must also be borne in mind that this rule applies only to dry gas, that is, gas perfectly free from moisture.

Since according to the above law the same weight or quantity of gas possesses very different volumes at different temperatures, it follows that in order to obtain proper comparisons between amounts of gas measured under different conditions of temperature, it is necessary to know the temperature at which the gas is measured in each case. Thus, if the tempera-

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ture of the gas as it passes through the station meter of a gas works varies considerably, either with the seasons or from any other cause, the working results will apparently be poorer when the temperature at the meter is low than they will when this temperature is high, though actually the reverse might be the case. Therefore, in order to obtain accurate figures for comparison it is necessary that the average temperature of the gas at the station meter be determined from the temperatures obtained by frequent observation, and that the volume of the gas as measured at these temperatures be reduced to the corresponding volume at a standard temperature, which is usually taken as 60°, and the working results calculated from this corrected volume. This correction of volume for temperature is also necessary if accurate information is to be obtained as to the actual amount of gas lost by leakage in the distributing system, since, if the temperature at the station meter is high and that at the consumers' meters low and no correction is made, the amount of gas unaccounted for will be much higher than the actual loss by leakage. (Trustees.)

8. What is the minimum size of pipe which it is considered advisable to use for services for ordinary dwelling houses? Give the reasons for your answer.

Ans. It is not considered good practice to use any pipe smaller than 1 in. for the services for ordinary dwelling houses which are within 40 feet of the street main, nor pipe smaller than 1¼ in. when the house is more than 40 feet from the main, and some engineers never use any pipe smaller than 1¼ in. even for shorter services.

The extra cost of the larger pipe is not a large percentage of the total cost of the service, while the use of such pipe provides for a possible increase in the amount of gas required, a provision which is especially necessary at the present time in view of the great development now going on in the sales of gas for fuel purposes. The use of the larger size of pipe also prevents trouble from any slight settlement of the service or from partial stoppages due to any other causes. A small amount of water, naphthalene or other deposit that would

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hardly be noticed in a 1¼ in. pipe would seriously affect the flow of gas through a ¾-in. pipe, and the extra first cost of the larger pipe is thus often offset by the saving effected by having fewer stopped services to deal with. The extra thickness of the larger pipe also gives it a longer life, especially if the pipe used for services is not coated before being laid. This longer life reduces the cost of service repairs. As will be seen by reference to the pipe cards the difference in thickness between ¾-in. and 1¼-in. pipe is 24% of the thickness of the smaller pipe.

The use of the larger pipe thus provides against the necessity for enlarging the service when a gas range or water heater is installed and also reduces the cost of maintenance and renewals. (Trustees.)

9. Flat flame burners are of two kinds, known respectively as fishtail and batswing burners. Give a description of each kind, and state which will give the greater amount of light from a given illuminating gas, the gas being consumed under the proper conditions to give the best result in each case.

Ans. Fishtail and batswing burners differ in the form of the tip and of the orifices in the tip from which the gas issues.

In the fishtail burner the top of the tip is usually concave, though in the poorer forms the tip has a flat top. The gas issues from the tip through two circular orifices set opposite each other. The axes of these orifices are set at an angle with each other so that the jets of gas meet and by the force of their impact are spread out into a sheet of flame in a plane midway between the orifices and at right angles to the line drawn through their centres. The shape of the flame produced by a fishtail burner is affected by the angle between the axes of the orifices through the tip, a very acute angle, producing a long and narrow flame which is widened and shortened as the angle is made more and more obtuse. The determination of the angle at which the greatest illuminating power per cubic foot of gas is produced is an important point in the design of a fishtail burner, as is also that of the proper size of orifice, since to

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secure the maximum results it is necessary to use different angles and sizes of orifice with different qualities of gas.

The tip of the batswing burner has a dome-shape top, varying from a hemisphere, or even a shape approximately ¾ of a sphere, to a very flat dome. The gas issues through a single orifice, which is a long narrow slit cut through the top of the dome to its lower edge and at right angles to its base. The gas issues from this slit in a sheet, the thickness of which is varied to suit the quality of the gas to be consumed, being thin for rich gases and thick for poor gases. There is little difference at present between the shape of the flame produced by the fishtail and batswing burners respectively, although as they were first designed the fishtail burner gave a long narrow forked flame and the batswing a short broad flame, whence the names.

Since it is necessary that the two circular jets in which the gas issues from a fishtail burner should come together with considerable velocity if the gas is to be well spread out and a good flame produced, this form of burner requires a higher pressure at the tip than is needed with a batswing burner and consequently the latter, as a rule, yields more light per cubic foot of gas than does the former when both are being worked under the proper conditions for the attainment of the best results. The fishtail burner is, however, much less apt to stop up than the batswing, and for this reason is given the preference by most gas companies, if any trouble is experienced from burner stoppages. (Trustees.)

10. Give a description, illustrated with sketches, of one or more forms of circulating gas water heaters for use in connection with ordinary kitchen boilers.

Ans. One form of gas water heater for use in connection with a kitchen boiler is made in the shape of a cylinder, from 7 in. to 10 in. in diameter and 27 in. to 30 in. high, which is suspended by the side of the boiler by means of the water pipes. (With the larger sizes the cold water pipe is extended down to the floor to give greater strength, but this is not necessary with the smaller sizes.)

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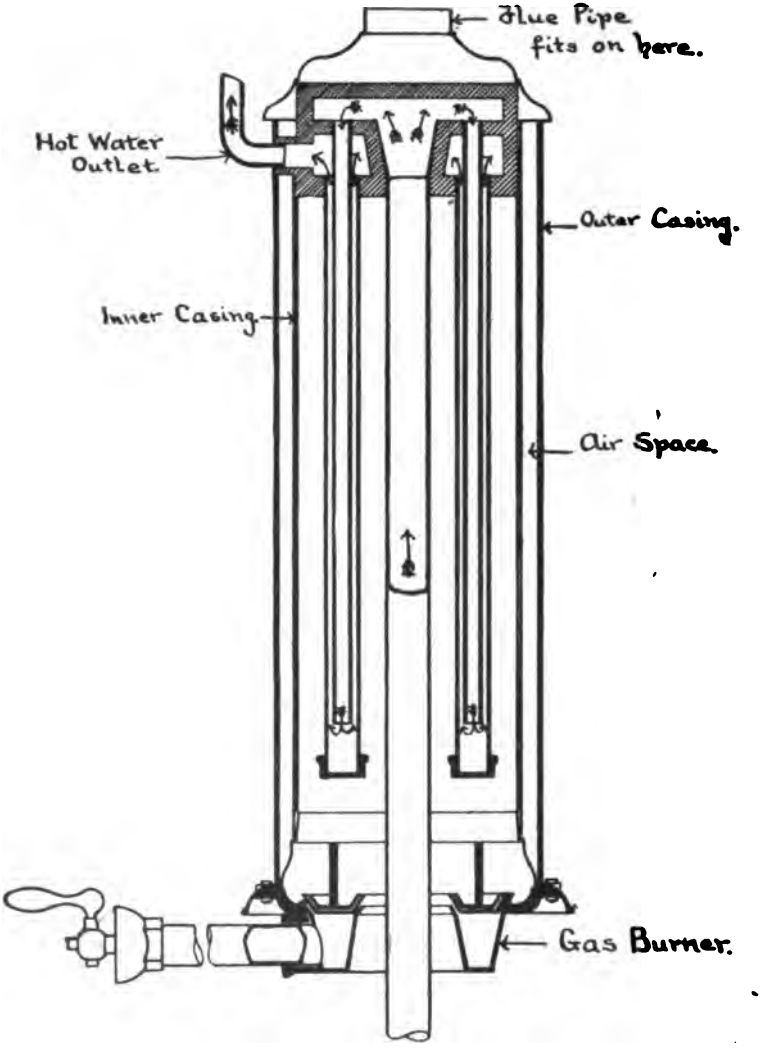

Circulating Gas Water-Heater.

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A cylindrical casing made of two concentric jackets of sheet steel, lined with asbestos and separated by an annular air space, encloses the burner and the water pipes and chamber. This casing is partially closed at the bottom by the burner and is covered at the top, the flue opening being in the centre of the cover.

The burner is an atmospheric ring burner capable of consuming from 30 to 60 cu. ft. of gas per hour, according to the size of the heater.

The cold water pipe comes in from the bottom through the centre of the burner, and passing to the top of the cylinder is screwed into the cold water compartment of a double water chamber. Into the lower side of this compartment a number of small tubes are screwed, being placed at equal distances apart around the circumference of a circle. Each tube is open at the lower end and is enclosed in a pipe (¾ in. to 1 in. in diameter) capped at its lower end and having the other end screwed into the bottom of the hot water compartment of the water chamber. A pipe leads from the side of this compartment to the top of the boiler.

The cold water entering by the central pipe passes up to the cold water compartment of the water chamber, then down through the small tubes nearly to the bottom of the cylinder and then up through the annular spaces between the tubes and the pipes enclosing them to the hot water compartment of the water chamber, whence it flows through the delivery pipe to the top of the boiler.

The hot products of combustion pass up the interior of the cylinder entirely surrounding the water pipes, which are thus exposed to the full effect of the heat produced by the combustion of the gas, and going around the water chamber pass out to the chimney. As the water flows in thin streams through the annular spaces in the pipes it is quickly heated, and this form of heater is both effective and economical.

Care must be taken to keep the flame from impinging on the lower ends of the water pipes, since if it does the combustion of the gas is checked and rendered incomplete and gas will be wasted. (Trustees.)

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11. What is meant by the term "light" used in designating the size of meters? Is the capacity per "light" the same in small meters, such as 3-lights, as in large meters, such as 100-lights?

Ans. The term "light" used in designating the size of gas meters is a conventional term which is supposed to indicate the number of lights or burners the consumption of which the meter is capable of supplying. It does not, however, afford an exact indication of the amount of gas which may be passed through the meter without overloading it, since its value expressed in the quantity of gas that may be delivered varies very much with the size of the meter. Thus a 3-light meter can easily supply 50 cubic feet per hour, so that in this case the value of a light is nearly 17 cubic feet per hour. A 100-light meter should not be called upon to pass more than 600 cubic feet per hour, which makes the value of the light for this size of meter only 6 cubic feet per hour. The value of a light is therefore not the same in small meters as in large meters. (Trustees.)

12. What are the relative advantages of brick and stone masonry for building construction?

Ans. "Brick-work is superior to stone masonry in several respects, as follows: 1. In many localities brick is cheaper than stone, since the former can be made near by, while the latter must be shipped. 2. As brick can be laid by less skillful masons than stone, it costs less to lay it. 3. Brick is more easily handled than stone, and can be laid without any hoisting apparatus. 4. Brick requires less fitting at corners and openings. 5. Brick masonry is less liable to great weakness through inaccurate dressing or bedding. 6. Brick-work resists fire better than limestone, granite or marble, sandstone being the only variety of stone that can compare with brick in this respect. 7. Good brick stands the effect of weathering and of the acids in the atmosphere better than sandstones, and in durability even approaches some of the harder stones. 8. All masonry fails when the mortar in its joints disintegrates or be-

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comes dislodged; therefore, brick masonry will endure the vicissitudes of the weather as well as stone masonry, or even better, since the former usually has thinner joints.

"Brick-work is not as strong as ashlar masonry, but costs less; while it is stronger and costs more than ordinary rubble." (Baker's Masonry Construction.)

The best grades of stone have greater compressive strength and durability than brick and are better for massive work, such as heavy abutments and piers for bridges and large foundations. In comparatively thin walls, however, a better bond can be obtained with brick than with stone and in such work the use of stone has been almost entirely abandoned in favor of brick except when the stone is employed for the purpose of ornament. In the class of buildings needed about gas works brick masonry is given the preference to stone masonry for the reasons stated in the quotation given above, except in places where good stone can be obtained either on, or very close to, the site of the works. (Trustees.)

NINTH SERIES OF QUESTIONS—SECTION OF 1908—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. What material would you put on the threads, or on the faces of flanges, when making up the joints in pipe lines to be used for crude oil, naphtha or gas oil?

2. Give a description, illustrated with sketches showing a vertical cross section, a vertical longitudinal section and a horizontal longitudinal section showing the nostrils in the furnace arch, the secondary air openings into the combustion chamber, and the openings through which the hot waste gases pass into the recuperators, of a setting of six retorts heated by a generator furnace and equipped with recuperators. Neither furnace nor recuperators need be illustrated except to the extent required to show the above-mentioned openings.

3. Describe, with sketches, the proper manner in which to make the feed-water and blow-off connections for steam boil-

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ers, and state the faults that are to be guarded against in making such connections.

4. Is it possible to have a single automatic overflow to remove both tar and liquor from the hydraulic main and at the same time maintain a liquor seal of constant depth on the dip pipes? Illustrate the reasoning by which you arrive at your answer by a sketch showing a cross section of the main and of such an overflow.

5. Boilers are often rated as being of so many horse-power. What is the meaning of the term "horse-power" when used in this connection? What is the meaning of the same term when applied to steam engines?

6. What horse-power is required for the actual work of pumping the gas by an exhauster handling 24,000 cubic feet of gas per hour with an inlet pressure of $^{3}/_{10}$ in. and an outlet pressure of 13 in.?

7. What is a vapor? What is the difference between a true gas and a vapor?

8. What is the maximum amount of gas containing 2.15 per cent. of carbon dioxide, CO_2, that can theoretically be purified by a bushel of unslaked lime containing 88 per cent. of calcic oxide, CaO, assuming that the weight of a bushel is 80 lb. and that carbon dioxide only is to be removed from the gas by the lime? Give all your calculations.

9. How would you calculate the maximum temperature that can be produced by burning any given sample of gas, the oxygen for combustion being derived from the atmosphere?

10. Describe some method of making iron oxide to be used for the removal of sulphuretted hydrogen from gas during its purification.

11. What is the Principle of the Conservation of Energy?

12. What tests would you apply to a fire brick to determine its quality?

(Answers to these questions are due May 1, 1907.)

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Answers to Ninth Series of Questions—Section of 1908—Practical Class—Trustees Gas Educational Fund.

Answers to questions Nos. 10 and 11 have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 10, Vol. I., page 248.

No. 11, Vol. I., page 204.

The answers to the other questions are as follows:

1. What material would you put on the threads, or on the faces of flanges, when making up the joints in pipe lines to be used for crude oil, naphtha or gas oil?

Ans. The Superintendent of a large carburetted water gas plant gives the following answer as the result of experience in running and maintaining oil lines at the works under his charge:

"Use common brown soap on the threads of pipe lines, to be used for crude oil, naphtha or gas oil; first making sure that the threads are clean and full depth and that the oil used in cutting these threads is burnt, or otherwise thoroughly cleaned off, before applying the soap. For the faces of flanges use a close grained fibrous cardboard for the small sizes, and either cardboard or a metallic gasket for the larger sizes; the latter preferred. The cardboard should not be more than $^1/_{16}$ of an inch thick for any size of flange, and if a metallic gasket is used, it is best made of an outer ring of copper and an inner ring of lead."

Thick shellac varnish is also used on pipe threads for oil lines and works well on lines carrying cold naphtha. Litharge mixed with glycerine is also used, but this becomes too brittle as it hardens to make a good job.

The one thing to be avoided is the use of any material mixed with linseed oil, since the petroleum oil rapidly attacks any such material, and joints made with it soon leak. (Trustees.)

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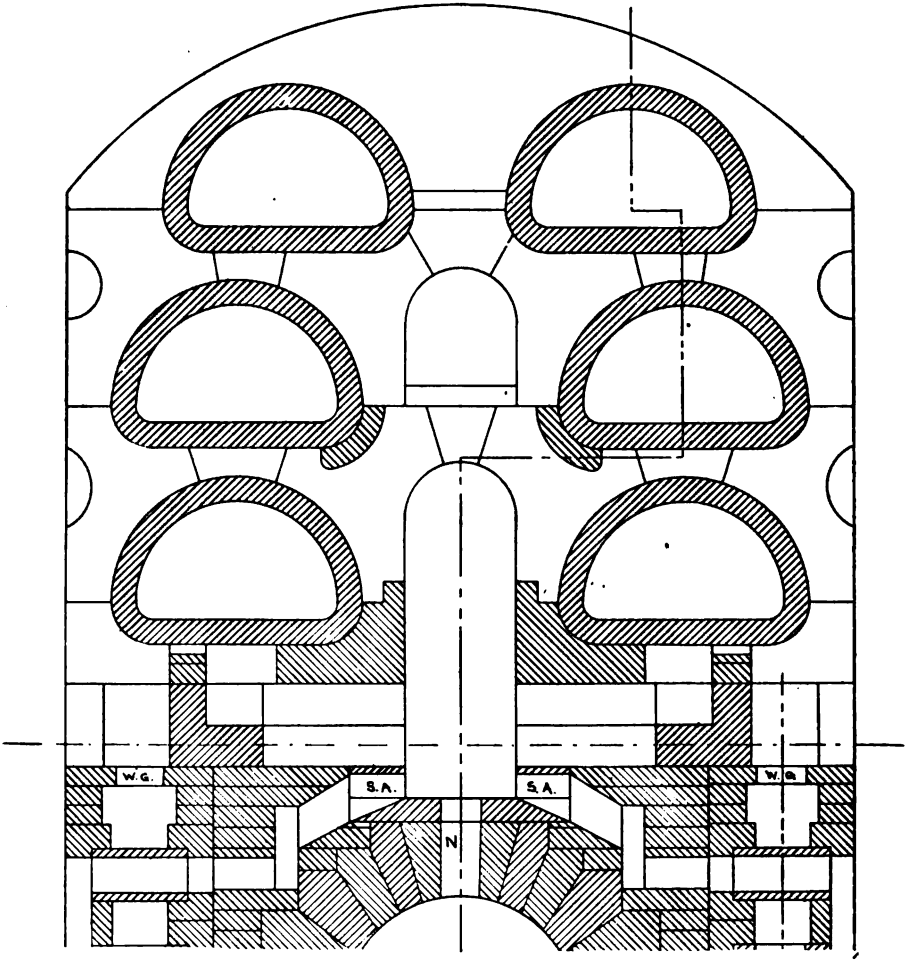
Bench of 6 Retorts. Regenerative Setting.
Vertical Cross Section.



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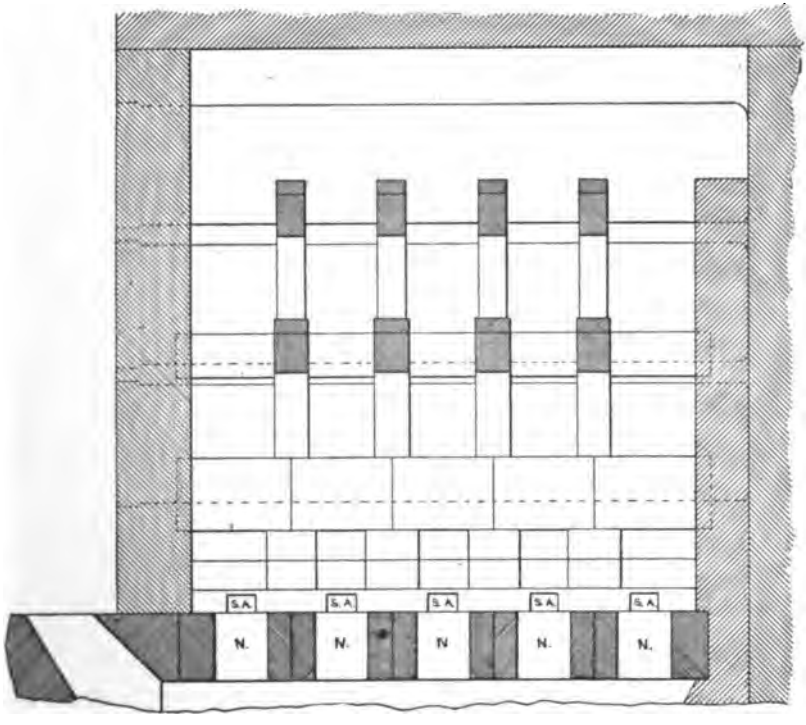
2. Give a description, illustrated with sketches, showing a vertical cross section, a vertical longitudinal section and a horizontal longitudinal section, showing the nostrils in the furnace arch, the secondary air openings into the combustion chamber, and the openings through which the hot waste gases pass into the recuperators, of a setting of six retorts heated by a genera-

Bench of 6 Retorts. Regenerative Setting.
Vertical Longitudinal Section.



tor furnace and equipped with recuperators. Neither furnace nor recuperators need be illustrated except to the extent required to show the above mentioned openings.

Ans. The regenerative setting of six retorts, which is illustrated by the accompanying sections, is designed to be

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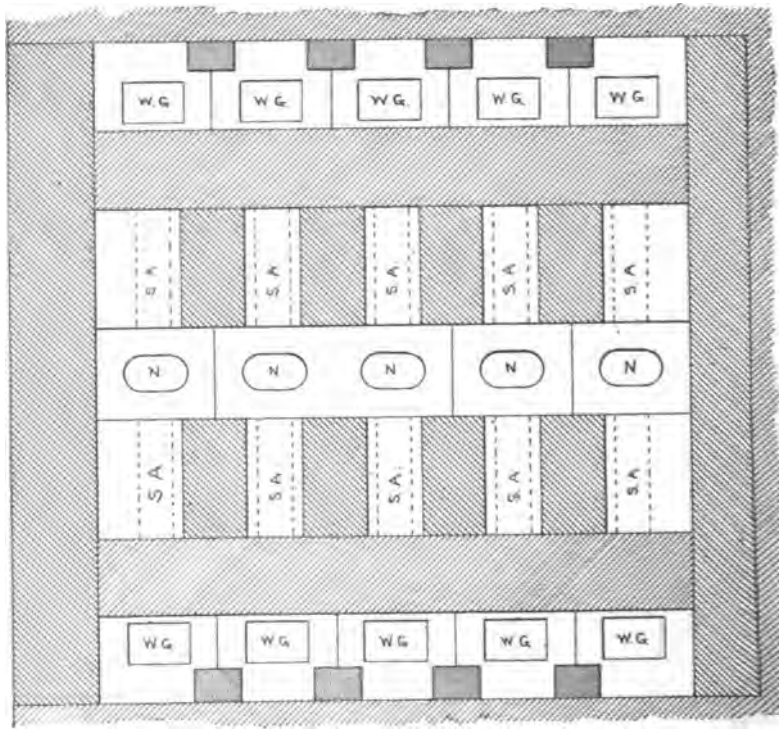
built in an arch 8 ft. 4 in. wide and to contain retorts, the inside measurements of which are 15 in. × 26 in. × 9 ft.

As will be seen from the cross section, the combustion chamber is made wide and high, being 14 in. wide and 3 ft. 6 in. from the top of the furnace arch to the bottom of the first

Bench of 6 Retorts. Regenerative Setting.
Horizontal Longitudinal Section along line
A B on the Vertical Cross Section



arch of the setting which crosses the combustion chamber. The producer gas enters this chamber by five openings, or nostrils, marked N, spaced equal distances apart from front to back along the centre line of the bench. The secondary air is admitted through the openings marked S.A. There are five of these on each side of the combustion chamber, level with the

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top of the furnace arch, each nostril having a secondary air opening opposite it on each side, so that two streams of secondary air are directed against each stream of producer gas.

The setting is built in one single chamber, the combustion taking place and the hot gases passing up around the retorts along the full depth of the bench. To secure effective heating of the bottom of the bottom retorts, small passages, which lead out of comparatively large openings left under the bottom retorts, as shown on the sections, carry some of the hot gases directly from the lower part of the combustion chamber to the outside flues. The bulk of the products of the secondary combustion, however, pass upwards and around the retorts, a portion passing out between the top of the bottom retort and the bottom of the middle retort, another portion passing out between the middle retort and the top retort, and the remainder going to the top of the setting and passing over the top of the top retort on each side. In whatever way the gases reach the space between the retorts and the outside wall on each side, they are drawn down through this space to the bottom of the setting and pass down into the recuperators through five openings. These openings, marked W. G. on the sections, are spaced like the nostril openings, equal distances apart from front to back of the bench, and by them an even distribution of the waste gases through the whole depth of the recuperators is secured.

The setting is a skeleton one, no more bricks and blocks being used than are necessary to support the retorts and prevent the heat from passing out the front of the bench. For the latter purpose the front wall is made 13 in. thick. The retorts are supported at the front by this front wall, at the back by a wall 9 in. thick, and at four points between these walls by blocks made of the proper shape to fit the outside of the retorts and form supporting arches, which carry the retorts and relieve the lower ones of the weight of those above them. The blocks supporting the inside lower corners of the bottom retorts are made continuous for the whole length of the retorts so as to protect them from the great heat existing in this part of the setting and from the cutting action of the flame,

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and shield tiles are also provided for the inside lower corners of the middle retorts for the same object. At all other points the retorts are exposed to full contact with the products of combustion except where they are built in the front and back walls, or where they rest upon and are covered by the narrow supporting blocks. Since these blocks are only 5 in. or 6 in. wide it will be seen that much the largest portion of the surface of the retorts is exposed to the direct action of the heat.

The blocks and bricks forming the walls of the combustion chamber should be made of extra quality material in order to stand the heat to which they are exposed. The blocks above the top of the bottom retorts on the inside of these retorts and all the blocks on the outside of the retorts may be made of any good first quality material. (Trustees.)

3. Describe, with sketches, the proper manner in which to make the feed-water and blow-off connections for steam boilers, and state the faults that are to be guarded against in making such connections.

Ans. The manner of making the feed-water and blow-off connections to boilers necessarily varies with the type of boiler employed. Since horizontal return tubular boilers are used more extensively in gas works than any other type, this answer will be confined to the manner in which these connections should be made for boilers of this type.

'Two important points to be observed in the arrangement of the feed-water pipe in any case are that the comparatively cold feed-water should not be delivered directly against any portion of the shell of the boiler, especially if such portion is exposed to the fire, or to contact with the products of combustion, and that the outlet of the pipe should be so located with reference to the water-line, that as little as possible of the water would be siphoned out of the boiler in case of any accident to the feed-pipe accompanied by failure of the check valve to work.

Even if the feed-water is heated, it is much colder than the shell, and if it is allowed to impinge directly upon the shell, the metal is severely strained by the local cooling to which it is subjected while hot at all other points. It is, therefore, very

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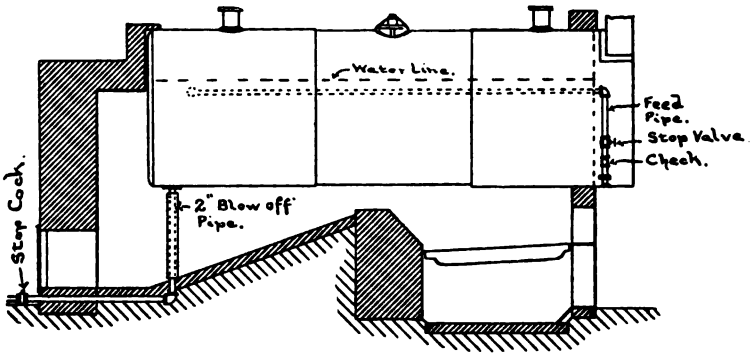

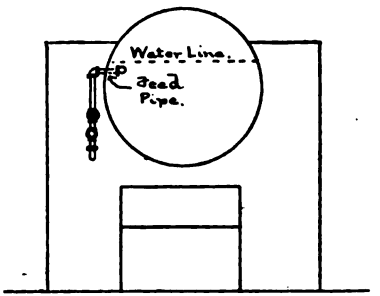

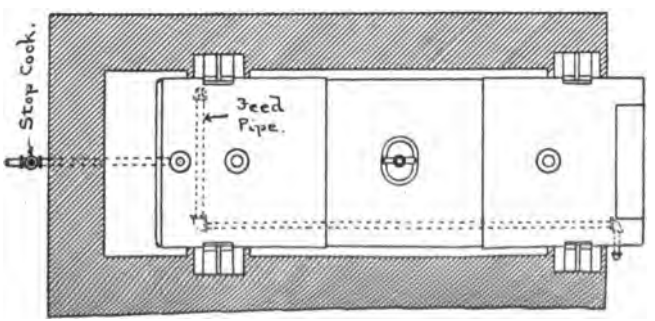

Feed Water and Blow-off Connections for Horizontal Jubular Boilers.

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poor practice to introduce the water directly at the bottom of the boiler, or when it is introduced at a higher point, to have it delivered in a direction that carries it directly against the bottom of the shell. These, however, are very common faults in connection with feed-water pipes. A good feed-water connection is shown on the cut. The pipe is brought up on one side of the boiler at the front (the check and stop valves being placed in the order named at a convenient height on the vertical run) to a point one or two inches below the low-water line, and then run horizontally parallel to the face of the boiler through the front smoke-box to a point about 6 in. from the side; then turned and run back through the front and parallel to the side of the boiler to about a foot from the back end; then again turned, still being kept horizontal, and carried at right angles across the boiler to a point about 6 in. from the shell on the other side where it ends in an elbow with the open end down. When the pipe is run in this way, the feed-water has an opportunity to become heated by passing through it and is delivered at a point where the water in the boiler is coolest and where there is apt to be a downward current. As the feed-water, even when admitted in this way, is cooler than the water in the boiler, it has a tendency to fall and its admission at the point named helps to secure a better circulation in the boiler.

This arrangement cannot be used with water containing much bi-carbonate of lime, since the deposit formed when water of this description is heated, would soon fill up the long internal pipe. In such cases, it is advisable to use a pipe only a few inches long, opening into an open trough or a pipe of larger diameter with the top cut away; this pipe extending the full length of the boiler. Such an arrangement distributes the water well and reduces to a minimum the danger of feed-pipe stoppages.

The feed-pipe to every boiler should be provided with a check valve set close to the boiler and in such a position that the valve opens vertically so that its weight assists the pressure of the boiler in closing it. A stop valve should be between the check valve and the boiler so that the check valve can be

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repaired, if necessary, without running the water out of the boiler.

The blow-off pipe is connected to the bottom of the boiler at the back end. It should be made of iron and not of brass or copper, since the latter metals are eaten away by the action of the hot gases to which a portion of the blow-off pipe is necessarily exposed. The part of the pipe so exposed should be covered with some non-conducting material, asbestos rope wound round the pipe being often used. Only straight way valves or stop cocks should be employed for shut-offs, and the openings in them should be at least the full size of the pipe. A tortuous passage, such as is found in globe valves, affords an opportunity for the trapping of loose pieces of scale against which more pieces collect until the pipe is completely choked up. With a straight way opening of the full size of the pipe, this cannot happen. Gate valves are open to the objection that scale can accumulate in the depression into which the bottom of the valve fits when it is closed and thus prevent the valve from closing tight. In spite of its tendency to stick, a full opening stop-cock forms the best shut-off for a blow-off pipe, but it must be opened full every time the blow-off is used, and care must be taken to shut it slowly to avoid subjecting the pipe to the great increase of pressure produced when the flow of water is stopped abruptly by the sudden shutting of the stop-cock, since this pressure will sooner or later cause a burst either in the pipe or in the fittings through the strain which it throws upon them. A tee should be inserted in the blow-off pipe just behind the cock so that its tightness when closed can be determined by taking the plug out of the side outlet of the tee and observing whether any water is trickling through the pipe. A tight joint should be made between the end of the blow-off pipe and the drain into which it is led to prevent the hot water splashing back on the boiler attendant. The blow-off pipe should be of good size, at least 2 in. in diameter. (Trustees.)

4. Is it possible to have a single automatic overflow to remove both tar and liquor from the hydraulic main and at

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Figure 1.

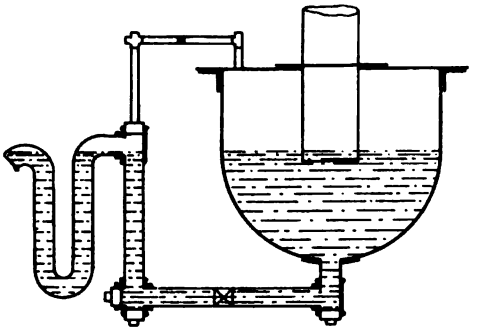


Figure 2.

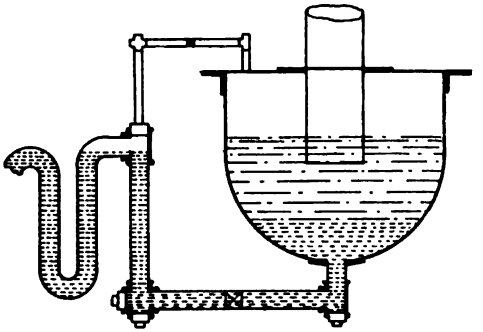
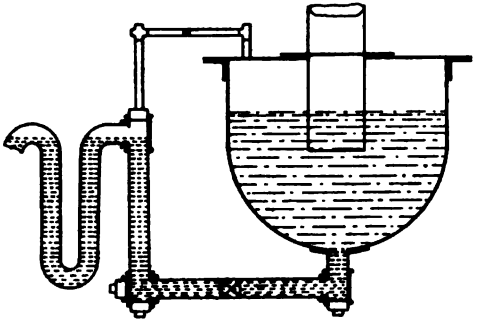


Figure 3.



Liquor

Jar.

Sketches showing how the Seal varies in an Hydraulic Main fitted with a Single Overflow for both Jar and Liquor.

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the same time maintain a liquor seal of constant depth on the dip pipes? Illustrate the reasoning by which you arrive at your answer by a sketch showing a cross section of the main and of such an overflow.

Ans. Owing to the difference between the specific gravities of tar and ammoniacal liquor it is not possible to have a single automatic overflow for the removal of both tar and liquor from the hydraulic main and at the same time maintain a seal of constant depth on the dip pipes. Such an overflow must connect to the bottom of the main, since otherwise some tar will be allowed to stay in the main indefinitely and gradually stiffen up until it can only be removed by scrapers. The accompanying cut shows cross sections of a hydraulic main with a single overflow opening out of the bottom and serves to illustrate the description of its action which follows.

The main being filled with liquor at the start the conditions are as shown in figure No. 1, the liquor in the two legs of the syphon formed by the main and overflow standing at the same level, and the dip pipes being under the proper seal. But when the main is in operation tar soon accumulates and settles to the bottom, and then nothing but tar can enter the overflow and pass over to its outside leg, as shown on figure No. 2. In this outside leg there is then a column of tar only, while the balancing column in the other leg is composed partly of tar and partly of liquor. The liquor being lighter than the tar this column of tar and liquor cannot support a column of tar of equal height, and before the tar in the outside leg of the syphon can rise to the level of the overflow and run off, the liquor in the main must rise above this level by an amount which depends upon the length of the outside leg and the proportion of the height of the inside leg which is occupied by the liquor. The seal on the dip pipes will thus be made greater than it should be, as shown on figure No. 2.

Since as long as there is any tar in the main there will be nothing but tar in the outer leg of the overflow and nothing but tar will run off from the main, all the liquor that is formed accumulates, until finally as the tar runs off, the main

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contains, as shown in figure No. 3, nothing but liquor standing at a level which is sufficiently high to more than balance the tar in the outer leg and drive it out of the overflow. When this happens there will be liquor on both sides of the syphon, and therefore the heights of the two columns will equalize themselves by the rapid flowing out of the liquor from the main until the level has been brought back to the normal water line, at which it will stand until enough tar accumulates to again cut off the liquor from the overflow and fill the outer leg, causing a repetition of the sequence of events previously described.

It is, therefore, evident that with such an arrangement of overflow, the water line in the main is continually varying and the depth of the seal on the dip pipes is anything but constant. To secure a seal of constant depth and at the same time remove both tar and liquor automatically it is necessary to adopt an arrangement of double overflows. (Trustees.)

5. Boilers are often rated as being of so many horse-power. What is the meaning of the term "horse-power" when used in this connection? What is the meaning of the same term when applied to steam engines?

Ans. The term "horse-power" as applied to the rating of boilers is used in two different ways: either as an absolute unit, by which to measure the rate at which the boiler will work, or as an approximate measure of the capacity of the boiler, to be applied in buying, selling or describing it for trade purposes.

The trade or commercial horse-power is determined according to certain arbitrary assumptions from the dimensions of the boiler, the extent of the heating surface being usually employed for this rating on a basis of 12 square feet of such surface for each horse-power. Thus, a boiler having a heating surface of 1,200 square feet would be ordinarily rated as being of 100 horse-power. The practice in this respect is, however, not uniform and it is necessary when comparing different ratings of boiler capacity, especially in passing upon proposals for the supply of new boilers, to know upon what rule each

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rating is based. A rough-and-ready rule for approximating the commercial horse-power of either tubular or water tube boilers has been given by the Engineering News as follows: Multiply the number of tubes by their length in feet and the product so obtained by the diameter of the tube in inches, then divide the final product by 50, and the quotient so obtained will be the horse-power of the boiler. The commercial horse-power is also sometimes determined from the grate surface, $^1/_3$ of a square foot being allowed per horse-power.

When used in engineering work for an accurate measure of the rate at which a boiler will do work the term "horse-power" has been defined by a committee of the American Societv of Mechanical Engineers as meaning "an evaporation of 30 lb. of water per hour from a feed-water temperature of 100° F. into steam at 70 lb. gauge pressure, which shall be considered equal to 34½ units of evaporation, that is, to 34½ lb. of water evaporated from a feed-water temperature of 212° F. into steam at the same temperature. A boiler should only be rated at the power which it is capable of developing with easy firing, moderate draft and ordinary fuel while exhibiting good economy, and should be capable of developing at least $^1/_3$ more than its rated power to meet emergencies."

When applied to steam engines, the term "horse-power" is used to indicate the rate at which mechanical work is done, and denotes the performance of work at the rate of 550 foot pounds per second, or 33,000 foot pounds per minute. A foot pound of work is the work done in raising the weight of 1 lb. through a height of one foot, or of overcoming a resistance of 1 lb. through a distance of 1 ft., or of overcoming any smaller or larger resistance through a correspondingly greater or less space per minute. (Trustees.)

6. What horse-power is required for the actual work of pumping the gas by an exhauster handling 24,000 cubic feet of gas per hour with an inlet pressure of $^3/_{10}$ in. and an outlet pressure of 13 in.?

Ans. The term "horse-power" as used to indicate the rate at which mechanical work is done denotes the performance of

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33,000 foot pounds of work per minute, that is, the raising of a weight of 33,000 lb. through a height of one foot, or the overcoming of a resistance of 33,000 lb. through a space of one foot, or of any smaller resistance through a correspondingly greater space per minute. The horse-power required to pump gas can therefore be calculated by dividing the product of the resistance overcome and the space through which it is overcome in a minute, by 33,000, the resistance being measured in pounds per square foot and the space in feet. The resistance is determined by the net pressure against which the exhauster is working, that is, by the difference between the pressure at the outlet and that at the inlet of the exhauster. The space can be taken as the number of cubic feet of gas pumped in a minute without any reference to the actual velocity with which the gas passes through the outlet pipe, since with a given outlet pressure the total resistance against which the exhauster is working varies directly as the area of the outlet pipe, while the velocity of the gas, or the space passed through in the unit of time varies, when the same quantity is pumped per minute, inversely as the area of this outlet pipe, and therefore the product of the total resistance and the space passed through will always be equal to the product obtained by multiplying the resistance per square foot by the number of cubic feet of gas pumped in the unit of time. The pressure is usually given in terms of the height, in inches, of the column of water which it will balance, and to convert this to pounds per square foot it is necessary to multiply it by the weight of a column of water one square foot in area and one inch high. A cubic foot of water weighs 62.5 lb., so a column of water 12 in. high exerts a pressure of 62.5 lb. per square foot, and a column 1 in. high will exert a pressure of $62.5 \div 12 = 5.2$ lb. per square foot.

The horse-power required for the actual work of pumping the gas can therefore be determined by multiplying the number of cubic feet pumped per minute by the product obtained by multiplying the net pressure in inches of water by 5.2 (which gives the pressure in pounds per square foot against which the exhauster is working) and dividing the final product by 33,000. Putting this rule into the shape of a formula we have:

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$$\text{H. P.} = \frac{VH \times 5.2}{33{,}000}, \text{ in which}$$

V = number of cubic feet of gas pumped per minute, and

H = the difference between the outlet and inlet pressures in inches of water.

In the present problem

$$V = \frac{24000}{60} = 400, \text{ and}$$

H = 13 in. — 0.3 in. = 12.7 in. so

$$\text{H. P.} = \frac{400 \times 12.7 \times 5.2}{33000} = \frac{400 \times 66.04}{33000} = \frac{26416}{33000} = 0.8005, \text{ and}$$

therefore the horse-power required for pumping the gas, without taking into consideration the friction of the exhauster, or any other losses of power in the machinery, is 0.8005 horse-power.

From the information obtained by a series of tests made on exhausters pumping gas into outlying holders, in which tests the amount of gas pumped, the pressure against which it was pumped and the horse-power developed in the engines doing the work were all determined, Mr. Geo. J. Roberts works out the following formula to be used in determining the total horse-power required in any given case when the gas is to be handled with an exhauster of the Wilbraham type.

H.P. = 0.00511 × H × V, in which

H = the net pressure in inches pumped against, and

V = thousands of cubic feet pumped per hour.

Substituting the values of H and V in the present problem we have:

$$\text{H.P.} = 0.00511 \times 12.7 \times 24 = 1.56.$$

So that the total horse-power required according to this formula is nearly double that required for pumping the gas. Or, in other words, the efficiency of the engine and exhauster when working at this rate is only about 50%. (Trustees.)

7. What is a vapor? What is the difference between a true gas and a vapor?

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Ans. Vapor, in physics, is the gaseous form which a solid or a liquid substance assumes when sufficiently heated. (Century Dictionary.)

As usually employed vapor denotes the gaseous form of a substance which under ordinary conditions of pressure and temperature exists in a solid or liquid form. Thus, in common language, a difference is recognized between vapors and so-called true gases, since the latter are substances which exist normally in a gaseous state and can only be liquefied by being subjected to great pressure or intense cold, or both. There is, however, no real physical difference between these two classes of gaseous forms, as it has been found possible to liquefy all gases and thus bring them before liquefaction into a condition exactly the same as that of vapors at ordinary temperatures and pressures.

What is called a vapor is a substance in gaseous form near the point of saturation, that is, near the point at which any further increase of pressure or decrease of temperature will cause a portion of the substance to condense into the liquid or the solid state, while what is called a true gas is a substance in gaseous form, far removed from its points of saturation, and therefore capable of being compressed and cooled without the occurrence of any condensation.

The difference between a "vapor" and a "true gas" is thus merely comparative, being the same that exists to a lesser degree between saturated steam and superheated steam, and, strictly speaking, no known substance can be termed a true gas, since none with which we are acquainted is sufficiently removed from the point of saturation to obey perfectly the laws of expansion and contraction under changes of pressure and temperature that would apply to absolutely perfect gases according to the molecular theory of matter, though the gases which are farthest removed from the point of saturation and therefore the hardest to liquefy, such as hydrogen, conform very closely to these laws. (Trustees.)

8. What is the maximum amount of gas containing 2.15 per cent. of carbon dioxide, CO_2, that can theoretically be

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purified by a bushel of unslaked lime containing 88% calcic oxide, CaO, assuming that the weight of a bushel is 80 lb. and that carbon dioxide only is to be removed from the gas by the lime? Give all your calculations.

Ans. As the bushel of lime weighs 80 lb. and contains 88% of CaO it will contain 70.4 lb. of CaO. When the lime is slaked, hydrate is formed according to the reaction.

Lime.		Water.		Calcic hydrate.
CaO	+	H_2O	=	$Ca(HO)_2$

Since the atomic weight of calcium (Ca) is 40, that of oxygen (O) 16 and that of hydrogen (H) 1, the respective weights are $(40 + 16) + (2 + 16) = [40 + (17 \times 2)]$, or $56 + 18 = 74$. That is 56 lb. of CaO will make 74 lb. of $Ca(HO)_2$ and 70.4 lb. of CaO will make $70.4 \times \frac{74}{56} = 70.4 \times 1.321 =$ 93.00 lb. of $Ca(HO)_2$.

The equation of the reaction between $Ca(HO)_2$ and CO_2 is: $Ca(HO)_2 + CO_2 = CaCO_3 + H_2O$, the weights being $[40 + (17 \times 2)] + [12 + (16 \times 2)] = [40 + 12 + (16 \times 3)] + [(1 \times 2) + 16]$ or $74 + 44 = 100 + 18$.

We are only concerned with the first half of the equation, from which we see that 74 lb. of $Ca(HO)_2$ will combine with 44 lb. of CO_2. Therefore 93.00 lb. of $Ca(HO)_2$ will combine with $93.00 \times \frac{44}{74} = 55.30$ lb. of CO_2. CO_2 dry at 60° Fahrenheit and 30 in. barometer weighs 1 lb. for each 8.595 cubic feet, so 55.30 lb. will be $55.30 \times 8.595 = 475.30$ cubic feet. The gas in question contains 2.15% of CO_2, or 21.5 cubic feet per 1,000 cubic feet. $\frac{475.30}{21.5} = 22.107$ and 22,107 cubic feet is the maximum amount of gas containing 2.15% of CO_2 that can be purified by a bushel of unslaked lime weighing 80 lb. and containing 88% of CaO. Of course, even this result could not be reached in practice, as it is never possible to entirely saturate all the calcic hydrate with carbon dioxide

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under working conditions, even assuming that all the other impurities that would combine with $Ca(HO)_2$ are removed by other means. (Trustees.)

9. How would you calculate the maximum temperature that can be produced by burning any given sample of gas, the oxygen for combustion being derived from the atmosphere?

Ans. The highest temperature that can theoretically be obtained by burning a gas in air is the temperature that will be reached when no heat is lost in any way, all the heat developed being employed to heat up the products of combustion and the nitrogen accompanying the oxygen drawn from the air for this combustion. These conditions are, of course, never obtained in practice, but, as it is very hard to measure accurately the losses that occur in practice, the maximum theoretical temperatures are used to furnish a basis for comparisons between different gases, it being assumed that the relations between the temperatures actually obtained will be very nearly the same as those existing between the theoretical temperatures, although the absolute temperatures will be very different in the two cases.

This maximum theoretical temperature evidently depends upon the quantity of heat developed by the combustion of a unit weight of the gas and upon the quantity of heat required to raise, by one degree, the temperature of the products resulting from the combustion of this unit weight and the quotient obtained by dividing the quantity of heat produced by the quantity required to raise the temperature of the products of combustion one degree will give the highest temperature that can be reached by burning the given gas. The quantity of heat produced is given by the calorific value of the gas. The amount of heat required to raise the temperature of the products of combustion one degree can be calculated by multiplying the weight of each product that is produced by its specific heat, the nitrogen mixed with the oxygen in the air and drawn into the flame with it being included. It is therefore necessary to determine what substances are produced by the combustion of the gas and the weight of each of these

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substances that is obtained from a unit weight of the gas, to multiply the determined weight of each substance by its specific heat and to add together the numbers obtained by these multiplications, the sum forming the divisor of the fraction.

The maximum temperature that can be produced by burning a gas in air can therefore be determined by dividing the calorific value of the gas, per pound, by the sum of the numbers obtained by multiplying the weight of each of the products of combustion produced from 1 lb. of gas by its proper specific heat, the nitrogen mixed in the air with the oxygen required for combustion being considered as one of the products of the combustion.

It has been found that the specific heats of gases increase quite rapidly with increase in temperature so that the use of constant values for the specific heats in problems involving widely differing temperatures does not give accurate results. In connection with a lecture delivered before the American Gas Light Association in 1903 (Proceedings, Vol. XX., Pages 296-299 inclusive), Mr. Alfred H. White gave tables showing the specific heats of the various products of combustion for temperatures varying by 100° C. from 100° C. to 2500° C. Copies of these tables with the temperatures converted into degrees Fahrenheit are given below. Inaccuracies in the experimental data on which these tables are based render it useless to attempt to interpolate more closely than 90°.

In using these tables it is necessary to assume a temperature and then use in the calculation the specific heats corresponding to this assumed temperature. If the calculated temperature does not agree closely with the assumed one it is necessary to assume another temperature and do the work over again, continuing this process until a close agreement is obtained between the assumed and the calculated temperatures.

To illustrate by a simple example, the maximum temperature that can be produced by the combustion of carbon monoxide, CO, may be determined as follows:

1 lb. of CO requires for its combustion to carbon dioxide CO_2, 0.571 lb. of oxygen, which will have mixed with it in the air $0.571 \times 3.31 = 1.89$ lb. of nitrogen, N_2, and the products

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TABLE OF MEAN SPECIFIC HEATS EXPRESSED IN B.T.U. PER POUND.

Degrees Fahrenh't	CONSTANT PRESSURE.				CONSTANT VOLUME.			
	Carbon Dioxide	Water Vapor	Nitrogen	Oxygen	Carbon Dioxide	Water Vapor	Nitrogen	Oxygen
212	0.201	0.446	0.244	0.214	0.156	0.337	0.174	0.152
392	0.210	0.462	0.249	0.218	0.165	0.353	0.179	0.156
572	0.219	0.478	0.253	0.222	0.174	0.369	0.183	0.160
752	0.227	0.494	0.257	0.225	0.183	0.385	0.187	0.164
932	0.236	0.510	0.262	0.229	0.192	0.401	0.192	0.168
1112	0.245	0.526	0.266	0.233	0.200	0.416	0.196	0.171
1292	0.254	0.541	0.270	0.237	0.209	0.432	0.200	0.175
1472	0.263	0.557	0.275	0.241	0.218	0.448	0.205	0.179
1652	0.271	0.573	0.279	0.244	0.227	0.464	0.209	0.183
1832	0.280	0.589	0.284	0.248	0.236	0.480	0.213	0.187
2012	0.289	0.605	0.288	0.252	0.244	0.496	0.218	0.190
2192	0.298	0.621	0.292	0.256	0.253	0.512	0.222	0.194
2372	0.307	0.637	0.297	0.260	0.262	0.528	0.226	0.198
2552	0.315	0.652	0.301	0.264	0.271	0.544	0.231	0.202
2732	0.324	0.668	0.305	0.267	0.280	0.560	0.235	0.206
2912	0.333	0.684	0.310	0.271	0.288	0.575	0.239	0.209
3092	0.342	0.700	0.314	0.275	0.297	0.591	0.244	0.213
3272	0.351	0.716	0.318	0.279	0.306	0.607	0.248	0.217
3452	0.360	0.732	0.323	0.282	0.315	0.623	0.253	0.221
3632	0.368	0.748	0.327	0.286	0.324	0.639	0.257	0.225
3812	0.377	0.764	0.331	0.290	0.332	0.655	0.261	0.229
3992	0.385	0.780	0.336	0.294	0.341	0.671	0.266	0.232
4172	0.394	0.796	0.340	0.298	0.350	0.687	0.270	0.236
4352	0.403	0.812	0.344	0.301	0.359	0.703	0.274	0.240
4532	0.412	0.828	0.349	0.305	0.368	0.719	0.279	0.244

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of the combustion of 1 lb. of CO will therefore be 1.571 lb. of CO_2 and 1.89 lb. of N_2. The calorific value of CO is 4383 B.t.u. per pound. Assuming a flame temperature of 3632° the specific heats of CO_2 and N_2 are respectively 0.368 and 0.327 and the equation for the maximum temperature in degrees Fahrenheit is, $T = \frac{4383}{1.571 \times 0.368 + 1.89 \times 0.327} = \frac{4383}{1.196} = 3665°$ F. Adding 60° to this flame temperature would be 3725°. The difference between the assumed and the calculated is too great, so it is necessary to make another calculation.

Assuming 3812° as the temperature, the specific heats of CO_2 and N_2 are found to be 0.377 and 0.331 respectively and the maximum temperature is, $T = \frac{4383}{1.571 \times 0.377 + 1.89 \times 0.331} = \frac{4383}{1.218} = 3599°$ F. Adding 60° to this the flame temperature would be 3659°, and again the difference between the assumed and the calculated is too great. But in this case the assumed temperature is larger than the calculated, while in the first calculation the reverse was true, therefore it is necessary to interpolate between these two assumed temperatures because the table does not give intermediate temperatures.

Taking the temperature midway between the two already used, which is 90° greater than the first temperature assumed and 90° less than the second, and is as close as the table can be used, the specific heats of CO_2 and N_2 at 3722° are respectively 0.3725 and 0.329, and the maximum flame temperature in degrees Fahrenheit is

$$T = \frac{4383}{1.571 \times 0.3725 + 1.89 \times 0.329} = \frac{4383}{1.207} = 3631° \text{ F.}$$

Adding 60° to this the flame temperature would be 3691°. This is as near to the assumed as it is possible to figure from

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the table and can therefore be taken as the theoretical flame temperature of carbon monoxide gas. (Trustees.)

12. What tests would you apply to a fire brick to determine its quality?

Ans. The qualities desired in a fire brick are: infusibility, strength, regularity of shape, uniformity of composition and facility of cutting, and the tests to be applied to a fire brick should be such as will determine to what extent it possesses these qualities.

The degree of infusibility can be determined, to a certain extent, by an analysis of the material of which the brick is composed. If this analysis shows the presence of about 60% of silica, less than 6% of sesqui-oxide of iron and not more than 2% to 3% as a total of lime, magnesia and the hydrates of potassium and sodium, the brick probably possesses a high degree of infusibility. If the analysis shows more than 6% of sesqui-oxide of iron or 2% to 3% of the lime, magnesia, etc., the brick should be rejected. But exposure of the brick to the action of heat under the conditions to which it will be subjected when used furnishes the best test for infusibility. In coal gas works the test can be made by placing the brick in the combustion chamber of a regenerative bench. If, when the brick is removed after being exposed for a week or ten days to the heat of the combustion chamber, the edges and corners are found to be sharp, and the surfaces show no signs of incipient fusion, the brick may be passed as a first-rate quality, as far as infusibility is concerned. In water gas plants the space at the bottom of the superheater, in which the secondary combustion occurs, furnishes a good place for a test.

If the material of which the brick is made is well compressed during manufacture and the brick is hard burned there is no question as to its strength when cold. The degree to which compression has been carried is indicated by the weight of the brick, and a fire brick of the regulation size, 9 in.×4½ in. × 2⅝ in., should weigh from 7¼ lb. to 7½ lb. A well burnt brick usually shows a reddish tinge. A well compressed and well burnt brick will give a ringing sound when struck

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with a hammer. It is especially important that the bricks which are to be used for lining the furnaces of retort benches, or for lining water gas generators, should be hard, since they are subjected to a great deal of abrasion from the fuel and the clinkering bars, so that for this work hardness and strength are of more importance than infusibility. In the combustion chamber, on the contrary, infusibility is the most important quality, since the material used there is not exposed to any wear and tear except that arising from the effect of the heat. It may thus frequently happen that the same brick is not suitable for use both in the furnace and the combustion chamber.

An examination of the exterior of the brick is all that is necessary to determine whether or not it possesses regularity of shape.

Uniformity of composition can be tested by breaking the brick and examining the surface of the fracture. This should present a compact and uniform appearance, though not necessarily a close and fine texture. In fact, some authorities consider a coarse texture to be preferable. Uniformity of composition is also indicated by the giving out of a clear ringing sound when the brick is struck a sharp blow with a hammer.

Facility of cutting is important only as reducing the cost of labor and the amount of waste during the operation of laying the brick, and while desirable if it can be secured without sacrificing the more important qualities, it cannot be considered an equivalent for any one of them. (Trustees.)

SECOND SERIES OF QUESTIONS—SECTION OF 1910—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Give the meaning of the terms "run of mine," "¾-inch," and "1½-inch" as applied to bituminous coal, and state, with your reasons for the statement, which class of coal gives the best carbonizing results.

2. Name the principal shapes of cross-section that have been adopted for clay gas retorts and give a sketch of the cross-section which you think the best. Show on the sketch the

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principal dimensions of the cross-section and the thickness of the retort walls. Give the reasons for your choice.

3. Describe, somewhat in detail, the starting of a fire in, and the heating up to a working heat of a carburetted water gas apparatus of the generator superheater type, and the putting on, making and taking off of the first run.

4. The weight of a cubic foot of dry air at 60° F. and 30-in. barometric pressure is 0.076357 lb. The specific gravity of each of the gases named below is set opposite its name. Calculate the weight of a cubic foot of each gas at 60° F. and 30-in. pressure.

Methane or Marsh Gas	$C H_4$	0.55408
Ethylene or Olefiant Gas	$C_2 H_4$	0.96964
Ethane	$C_2 H_6$	1.0389
Carbon Monoxide	C O	0.96964
Carbon Dioxide	$C O_2$	1.5237
Oxygen	O_2	1.10816
Nitrogen	N_2	0.96964
Hydrogen	H_2	0.06926

5. A stand pipe 100 ft. high is filled with a gas which is lighter than air. The pipe is rigidly and hermetically sealed so that there is no communication between the air outside and the gas inside. Will the absolute pressure of the gas be the same at the top and at the bottom of the pipe? If the pressure is not the same, at which point will it be greater? Give the reasons for your answers.

6. What is meant by the atomic or combining weight of a substance? What use is made of this weight?

7. What is the unit used in Great Britain and America for measuring and expressing the illuminating value of gas, and what is the value of this unit?

8. What considerations determine the depth at which street mains should be laid, there being no question of interference with any other pipe systems?

9. Describe, with a sketch showing all the dimensions of drip and cover and the arrangement of the pumping pipe, a 6-in. line drip.

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10. Under what conditions must gas be burnt in luminous flame burners to secure the greatest possible yield of light?

11. Why are Bunsen or Atmospheric burners used in gas cooking stoves and incandescent gas lights? Why are they not used in the ordinary cylindrical gas heating stoves and gas radiators?

12. What is Rosendale or Utica cement, how is it made, and what tests should be applied to any given sample to determine its quality?

(Answers to these Questions are due June 1, 1907.)

ANSWERS TO SECOND SERIES OF QUESTIONS—SECTION OF 1910 —PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

Answers to questions Nos. 1, 10 and 11 have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 1, Vol. I., page 225.
No. 10, Vol. I., page 276.
No. 11, Vol. I., page 279.

The answers to the other questions are as follows:

2. Name the principal shapes of cross-section that have been adopted for clay gas retorts and give a sketch of the cross-section which you think the best. Show on the sketch the principal dimensions of the cross-section and the thickness of the retort walls. Give the reasons for your choice.

Ans. According to King's Treatise, clay gas retorts have been made with the following cross-sections: Square, square with rounded corners, round, oval and ⌂ shaped. The last three shapes have been the most used, and in recent years round retorts have almost entirely disappeared, leaving only the oval and ⌂ shapes in general use.

There is little to choose between these two shapes. In both the coal can be placed in the retort in a comparatively thin layer of uniform depth over its entire width, permitting of

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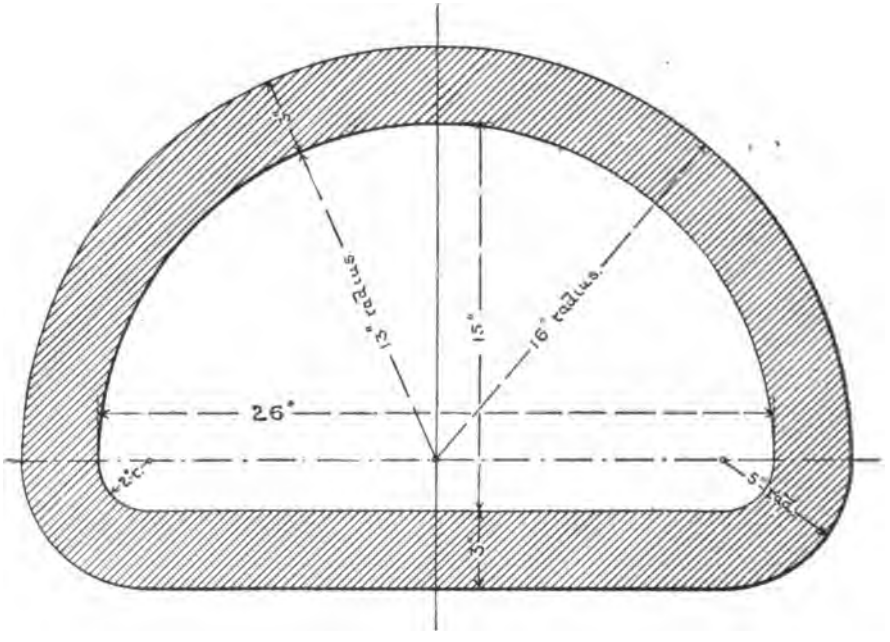
uniform carbonization. The oval retort is a little stronger sideways than the ⌂, but in a well-built setting there should not be any great side strain on the retorts, and as the ⌂ retort can be made with a semicircular top, it is better able to resist the vertical strains to which retorts are most liable to be subjected than is the oval, with its flatter top. It is easier to draw the



Cross Section of Clay Retort.

coke from an oval retort than it is from a ⌂ shaped one with sharp corners, but this difference disappears when the ⌂ is made with rounded corners, and this shape, in the form shown on the accompanying cut, is probably employed in this country to a greater extent than the oval.

The walls of the retort are usually made 3 inches thick with an increase to 4 inches or 4½ inches for about 9 inches to 12

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inches at the front end, for the purpose of giving the strength needed for carrying the weight of the mouthpiece. In one large coal gas works in this country the retorts are made with walls only 2½ inches thick.

The dimensions of the cross-section should be governed by the amount of the coal that is to be charged, and this depends on the heat that can be secured in the setting. It is bad practice to use in a setting that will not carbonize over 250 lb. of coal per charge the same size retort that is used in a setting that will carbonize 350 lb. of coal per charge, lasting an equal length of time. In recuperative benches in which heavy charges can be used the cross-section is usually taken as either 15 in. × 26 in. or 16 in. × 26 in. At one large works, however, retorts of the latter size have been replaced recently by 16 in. × 24 in. retorts and the change has resulted in the obtaining of better results. (Trustees.)

3. Describe, somewhat in detail, the starting of a fire in, and the heating up to a working heat of a carburetted water-gas apparatus of the generator-superheater type; and the putting on, making and taking off of the first run.

Ans. It is assumed that the apparatus has previously been in use and therefore does not require to be dried out, and also that during the time it has been out of use all necessary repairs have been made, so that all of the valves and piping are in good condition. Just before making the fire the pressure gauges and seals should be filled with water, and water should be started running through the water-cooled valve, if the apparatus is fitted for the reversal of steam. If the condenser is already full of water, no water need be turned on it, nor need any be turned on the scrubber until the set has been heated up and is ready to make gas. The superheater stack valve should be open, and the upper valve of the steam reversal attachment should also be open.

A layer of coarse ashes or clinkers from 6 in. to 12 in. deep should be spread over the grate bars to protect them from the overheating and warping that would take place during the long blow if the fire were built directly upon them. (If this

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is properly and carefully done there will be no danger of the bars becoming overheated, but in any case the bottom door of the generator should be opened after the blast has been on for, say, fifteen to twenty minutes, and if the fire is found to be too hot on the bars a little steam should be turned on with the blast to cool the lower part of the fire, and so protect the bars from injury.) The stoppers should be placed in the stoke holes and the stoke hole doors closed, the ashpit doors being left open. If the water-gas apparatus is used in combination with a coal-gas plant the fire can be started by putting into the generator, on top of the layer of clinkers, several barrows of hot coke, followed by a quantity of cold coke, or coal, sufficient to fill the generator half full. If no hot coke is available the fire must be started with wood, enough being used to insure the ignition of the coal or coke, which may either be put on before the wood is lighted, or else put on after the wood fire has gotten well under way. If the first method is employed the coal is put on the wood to a depth of one to two feet, and the wood is ignited from below, the charging lid of the generator being left open until the wood is burning freely, when it is closed, and the products of combustion are drawn through the carburetter and superheater. In this case old oil-soaked waste can be used as a kindling underneath the wood. If the coal is put on after the wood has been lighted no kindling is needed, since the fire can be started by throwing a couple of shovels of hot coal, taken from the boiler fire, on top of the wood. When the wood is burning briskly the coal can be charged to the proper depth and the charging lid closed.

In either case, when the wood has burnt out, leaving the coal well ignited, the generator lid should be opened, a torch being used as in regular running to avoid an explosion, the generator half filled with coal, the lid closed and screwed down, the ashpit doors closed and sealed up, and the generator blast valve opened, the blower having been previously started. After blasting for a sufficient length of time (say 20 to 30 minutes) to have the coal and upper part of the generator well heated and have the blast gas passing into the carburetter hot, the

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carburetter blast valve can be opened slightly, using an iron rod with its end heated to a bright red and put through the sight hole to ignite the gas as it meets the air. If the gas is hot enough, it will, when once ignited, continue to burn after the rod is withdrawn, and a blue flame will be visible through the sight hole, but if the gas is too cold the flame will go out when the rod is removed, and the blast must be shut off, to be turned on again later and a second attempt at ignition made.

When the carburetter shows a fair heat, as it will in about thirty minutes after the blast has been turned on to it, the superheater blast can be turned on, the ignition of the gas being effected by a rod heated at the end and inserted through the lower sight hole, the presence or absence of a blue flame after the rod is withdrawn indicating, as in the case of the carburetter, whether the blast can be left on or must be turned off until a higher temperature is reached.

The superheater having been successfully lighted, the blasting is continued until the carburetter and superheater are heated up to nearly the right temperature for gas making, the blast being so adjusted that all the combustible portion of the blast gas is consumed without having any excess of air on the superheater, and the generator being coaled when necessary. The total time required to bring the apparatus to this point after the blast is first turned on will be from 1½ to 2 hours. When it is reached the blast should be shut off, the generator filled with coal and the blasting resumed for from five to ten minutes more, to get the heats to the gas-making point.

When this is reached the blast valves are shut, beginning at the superheater and finishing at the generator, the steam is turned on, the stack valve closed, and finally, the oil pump started and the oil admitted to the carburetter. Before turning on the oil for this first run the pressure gauges should be looked at to see if the proper pressure is shown, and so make certain that everything is tight and that there are no large leaks that need to be stopped before gas making can be carried on. During the run the rate at which the oil is being fed into the apparatus must be watched and so regulated that the desired

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quantity is used. One minute before the end of the run the oil should be shut off in order to avoid loss of oil gas when the run is taken off. At the end of the time allowed for the run the steam is shut off, the stack valve opened, the blast turned on the generator, carburetter and superheater, in the order named, and the apparatus heated up for another run. (Trustees.)

4. The weight of a cubic foot of dry air at 60° F. and 30 in. barometric pressure is 0.076357 lb. The specific gravity of each of the gases named below is set opposite its name. Calculate the weight of a cubic foot of each gas at 60° F. and 30 in. pressure.

Methane or Marsh Gas	CH_4	0.55408
Ethylene or Olefiant Gas	C_2H_4	0.96964
Ethane	C_2H_6	1.0389
Carbon Monoxide	CO	0.96964
Carbon Dioxide	CO_2	1.5237
Oxygen	O_2	1.10816
Nitrogen	N_2	0.96964
Hydrogen	H_2	0.06926

Ans. Since the specific gravity of a gas is the ratio between the weight of any given volume of the gas and that of the same volume of air measured at the same temperature and pressure, or in other words, is the quotient obtained by dividing the weight of a given volume of the gas by the weight of an equal volume of air, the weight of a cubic foot of any gas can be found, the specific gravity of the gas and the weight of a cubic foot of air being known, by multiplying the weight of this volume of air by the specific gravity of the gas.

Thus the weight of a cubic foot of Marsh Gas, CH_4, is found by multiplying 0.076357 (the weight of a cubic foot of air) by 0.55408 (the specific gravity of marsh gas), and is equal to 0.042308 lb. All the weights given below are obtained in a similar manner.

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Methane or Marsh Gas	CH_4	0.042308 lb.
Ethylene or Olefiant Gas	C_2H_4	0.074039 "
Ethane	C_2H_6	0.079327 "
Carbon Monoxide	CO	0.074039 "
Carbon Dioxide	CO_2	0.11634 "
Oxygen	O_2	0.084616 "
Nitrogen	N_2	0.074039 "
Hydrogen	H_2	0.005288 "

5. A stand pipe 100 feet high is filled with a gas which is lighter than air. The pipe is rigidly and hermetically sealed so that there is no communication between the air outside and the gas inside. Will the absolute pressure of the gas be the same at the top and at the bottom of the pipe? If the pressure is not the same, at which point will it be greater? Give the reasons for your answer.

Ans. The only forces affecting the pressure in a pipe filled with gas and hermetically sealed, are the attraction of gravity and the pressure of the gas itself; that is, the force with which it presses against the sides of the pipe. According to the molecular theory of the composition of matter, this pressure, which is exerted against the sides of the containing vessel by a gas is due to the incessant striking against these sides of molecules, each of which is trying to get as far away as possible from the others. In the absence of any disturbing force this pressure is exerted equally in all directions, since all the molecules move with the same velocity and have the same weight, and consequently possess the same energy, and as many travel up as travel down or sideways; and if the gas was imponderable, that is, had absolutely no weight, the pressure would be the same at all points in the height of the pipe. But each molecule has some weight and therefore tends, under the influence of the attraction of gravity, to move downward. This tendency to move downward decreases the velocity of the molecules moving upward, while it increases that of those moving downward, and since the force with which the molecules strike against the sides of the pipe or against each other depends on the velocity with which they

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move the molecules moving upward do not strike as hard, and therefore do not exert as much force or pressure as those moving downward. The difference thus produced between the upward and the downward pressure is in every case equal to the weight of the molecules. As, owing to its weight, each molecule from the top down transmits a greater downward pressure than it receives from the molecules above it, the effect is cumulative, and the total pressure at the bottom of the pipe will be greater than that at the top by an amount equal to the weight of the gas in the pipe, and the pressure per unit of area will be greater at the bottom than it is at the top by an amount equal to the weight of a column of the gas of unit area and of the height of the pipe.

The same reasoning applies to the air in the earth's atmosphere, the pressure of which is greatest at the sea level and diminishes with the height above this level by an amount equal to the weight of a column of air of unit area and a height equal to the elevation of any given point above this level. (Trustees.)

6. What is meant by the atomic or combining weight of a substance? What use is made of this weight?

Ans. The atomic or combining weight of a substance is the ratio between the weight of an atom of the substance and that of an atom of hydrogen, the weight of the hydrogen atom being taken as unity, since it is the lightest of all known atoms. The atomic weights of the various elements do not, therefore, represent any absolute weights, but merely the number of times that the atoms of the respective elements are heavier than the atom of hydrogen.

Atomic weights are useful in calculating the proportionate weights in which various substances enter into combination with each other, or into any chemical reaction. Since all chemical compounds are formed by the combination of atoms or multiples of atoms of the various elements, the weights of the different elements in any compound must always be proportional to their atomic weights, and therefore knowing the atomic or proportionate weights of the atoms of the

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various elements in any compound, the proportionate weights of each of the elements contained in the compound, and of the compound itself, can be determined as soon as the formula of the compound, that is, the number of atoms of each element contained in it, is known. The same thing is true of the molecular weights of compound substances, since such substances always enter into chemical reactions in weights proportional to their molecular weights.

As an instance of the use of atomic weights, the formation of Carbon Dioxide (CO_2) may be taken. This gas is formed in the combustion of Carbon (C) by the union of Carbon and Oxygen (O_2). The equation of the reaction between the two substances is $C + O_2 = CO_2$, that is, one molecule of Carbon, consisting of one atom, unites with one molecule of Oxygen, consisting of two atoms, to form one molecule of Carbon Dioxide, consisting of one atom of Carbon and two of Oxygen. The atomic weight of carbon is 12 and that of oxygen 16, so the proportion by weight in which they unite is 12 of carbon to 32 of oxygen. That is, 12 lb. of carbon unite with 32 lb. of oxygen to form 44 lb. of carbon dioxide, and, whatever the weight of carbon, the weight of oxygen required for its combustion and the weight of carbon dioxide produced can be easily found from the above proportions.

In the same way the proportional weights in which any substances enter into chemical combination are determined from their atomic or molecular weights. (Trustees.)

7. What is the unit used in Great Britain and America for measuring and expressing the illuminating value of gas, and what is the value of this unit?

Ans. The unit used in Great Britain and America for measuring and expressing the illuminating value of gas is the "candle-power." The literal meaning of "candle-power," as a measure of illuminating value, is the amount of light given by the flame of a candle. It is, however, evident that the flames of different candles give different amounts of light, and therefore, to obtain an amount of light that shall be as nearly as

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possible a definite and unvarying quantity and fit to be used as a unit of measurement, it is necessary that the candles employed should be made and burned in accordance with certain rules. Candles so made and used are called standard candles.

It is also evident that after having obtained a standard candle, before any deductions can be made as to the comparative candle-powers of different gases as obtained by separate observations, it is necessary that the rates at which, and the burners in which the gas is consumed must be uniform, since the same gas consumed at different rates in one burner, or at the same rate in different burners, will give different amounts of light. Therefore, the term "candle power" implies the use of a standard candle burning at a definite rate and of a standard burner and rate of consumption for the gas.

The standard candle is a sperm candle of six to the pound and is burnt at a rate of 120 grains of sperm per hour. For a long time these general requirements were the only ones that had to be met, but wide variations in the amount of light given by different candles, all of which fulfilled the above requirements, led the London Gas Referees to adopt regulations for securing uniformity in standard candles, which prescribe the method and materials to be used in the manufacture of the wicks and the melting point of the spermaceti that are to be employed in making such candles. In the absence of any regulation on the subject in this country it is well to see that the candles used fulfil as nearly as possible the requirements of the Gas Referees. These requirements are given in full in Butterfield's "Chemistry of Gas Manufacture," First Edition, pages 249 and 252.

The standard rate of consumption for the gas is 5 cubic feet per hour. The form of burner used as the standard varies with the locality and the nature and quality of the gas to be tested. In England, for the testing of coal gas of from 14 to 16 candle-power, the burner originally prescribed by law for use as the standard burner was a special form of Argand burner known as Sugg's London Argand No. 1. In 1906 a new standard burner known as the Metropolitan Argand No.

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2, or the Carpenter burner, was adopted as the standard for London and is being rapidly adopted all over Great Britain. For cannel gas of from 20 to 26 candle-power a flat flame burner is commonly prescribed as the standard. In this country the No. 7 Bray Slit Union burner has been very generally adopted as the standard burner, especially where the gas to be tested is either a carburetted water gas or a mixture of this gas with coal gas. The London Argand is also used in many instances for coal gas. The New York Commission of Gas and Electricity has recently made regulations for the testing of gas in New York State, which provide that the tests of illuminating power shall be made with either a new style of F Argand burner, old style D Argand burner or No. 7 Slit Union Bray burner, as may be best suited to the gas tested. It is always necessary to note what burner has been employed as a standard in each case before any comparison can be made between the reported candle-powers of the gases supplied in different localities.

From what precedes it is seen that when it is said that a gas is of a certain candle-power the idea intended to be conveyed is that the gas will, when burned in a standard burner at the rate of 5 cubic feet per hour, produce a flame which gives a light equal to that given by a certain number of standard candles, each consuming 120 grains of sperm per hour. (Trustees.)

8. What considerations determine the depth at which street mains should be laid, there being no question of interference with any other pipe systems?

Ans. The principal considerations that determine the depth at which street mains should be laid are their protection from damage by the traffic passing over them and from the influence of the changes in the temperature of the atmosphere.

In Canada and the greater portion of the United States the depth at which mains are laid is governed by the latter consideration, since the depth required for protection from frost is greater than that required for protection from the traffic car-

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ried on along the roadway above the pipes. The customary rule is to keep the top of the mains just below the normal frost line. In the vicinity of New York City this requires the mains to be laid with three feet of cover, while in Canada and the Northern and Northwestern parts of the United States, in which the winters are very severe, the depth may reach six feet.

In the Southern States, where the winters are mild, the changes in temperature are of minor importance and the mains need not be laid any deeper than is necessary to protect them from the traffic passing over them. For this purpose a depth of 24 in. is sufficient, except in business streets where the traffic is apt to be heavy, in which case 2 ft. 6 in. of cover should be given.

When the temperature and traffic conditions are such as to permit of the mains being laid comparatively near the surface, the character of the pavements, either already existing or which will probably be laid in the future, must be taken into consideration and the mains laid deep enough to obviate any danger of the service pipes being interfered with during the laying or repairing of the pavement.

Other pipe systems and subsoil structures also affect the problem at times, but, as stated in the question, these were to be left out of consideration for the purposes of this answer.

Nothing is gained by going below the depth determined as above, and the deeper the mains the greater is the expense incurred both in their installation and their maintenance. It is therefore advisable not to go any lower than is necessary. (Trustees.)

9. Describe, with a sketch showing all the dimensions of drip and cover and the arrangement of the pumping pipe, a 6-inch line drip.

Ans. A line drip is a cylindrical vessel made of cast iron. It has a solid bottom and is closed at the top by a removable cover which is usually fastened in place with a lead joint, the lead being run and caulked into a joint space between the cover and the drip. Hubs or bells of the proper size are cast on

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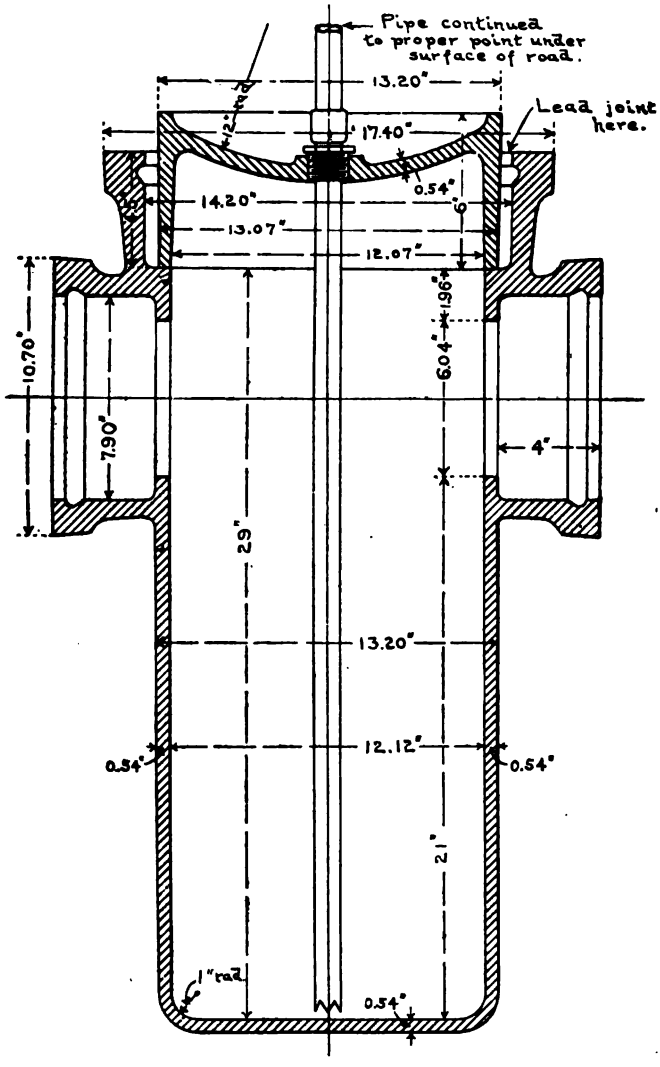

6-inch Line Drip.

Bells made according to standard.

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opposite each other near the top, and by means of these the drip is inserted into the pipe line at the low points and forms part of the line, the gas passing through its upper part while the condensation falls to the bottom.

The condensation is pumped from the drip by a vertical wrought iron pipe, ¾ in, or 1 in. in diameter, screwed through a 1¼ in. × 1 in. or a 1¼ in. × ¾ in. bushing which is screwed into the cover. The lower end of the pipe is serrated and almost touches the bottom of the drip, and there is screwed on the end projecting above the cover another piece of such a length that the upper end is just below the level of the roadway, in which is set a drip-box which protects the pipe and at the same time renders it accessible. When the drip is to be pumped, the cap, by which the upper end is closed, is removed and a drip pump screwed on. Sometimes the pumping pipe instead of being carried up vertically to the surface is run under the surface to the curb and then brought to the top.

The cut shows a section of a 6-inch drip made according to the standards adopted by the American Gas Light Association. (Trustees.)

12. What is Rosendale or Utica cement, how is it made, and what tests should be applied to any given sample to determine its quality?

Ans. Rosendale or Utica cement, also called natural cement, is made from limestones composed of carbonate of lime, carbonate of magnesia and clay. The limestone is burned in a kiln and then ground to a fine powder. "Any magnesian limestone containing as high as 60 per cent. of carbonate of magnesia may be presumed to be capable of yielding hydraulic cement of greater or less value, if properly burned, no matter whether clay be present or not."

Cement should be tested for fineness, liability to cracking and tensile strength.

"Fineness. 90 to 95 per cent. of the cement should pass through a sieve of 2,500 meshes per square inch. Other qualities being equal, the finer a cement is ground the greater is its value.

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"Checking or Cracking. The test for checking or cracking is an important one, and though simple, should never be omitted. It is as follows:

"Make two cakes of neat cement 2 or 3 in. in diameter, about ½ in. thick, with thin edges. Note the time in minutes that these cakes, when mixed with the water to the consistency of a stiff, plastic mortar, take to set hard enough to stand the wire test recommended by Gen. Gillmore, $^1/_{12}$-inch diameter wire loaded with one-fourth of a pound, and $^1/_{24}$-inch loaded with 1 pound. One of these cakes, when hard enough, should be put in water and examined from day to day to see if it becomes contorted or if cracks show themselves at the edges, such contortions or cracks indicating that the cement is unfit for use at that time. In some cases the tendency to crack, if caused by the presence of too much unslaked lime, will disappear with age. The remaining cake should be kept in the air and its color observed, which, for a good cement, should be uniform throughout (yellowish blotches indicating a poor quality), the natural cements being light or dark according to the character of the rock of which they are made. The color of the cements when left in the air indicates the quality much better than when they are put in water.

"Tensile strength. The tests should be applied to the cement as offered for sale. The following table gives the average minimum tensile strength per square inch which some good cements have attained.

AVERAGE TENSILE STRENGTH IN POUNDS PER SQUARE INCH.

AGE OF MORTAR WHEN TESTED.	ROSENDALE.	
CLEAR CEMENT.	MIN.	MAX.
1 day—1 hour, or until set, in air, the remainder of time in water	40	80
1 week—1 day in air, the remainder of time in water	60	100
4 weeks—1 day in air, the remainder of time in water	100	150
1 year—1 day in air, the remainder of time in water	300	400

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ONE PART CEMENT AND ONE PART SAND.

1 week—1 day in air, the remainder of the time in water	30	50
4 weeks—1 day in air, the remainder of the time in water . . .	50	80
1 year—1 day in air, the remainder of the time in water . . .	200	300

"If satisfactory results are obtained with a full dose of sand, the trials need go no further. If not, the coarser particles should be excluded by using a No. 100 sieve, in order to determine approximately the grade the cement would take if ground fine, for fineness is always attainable, while inherent merit may not be.

"Weight. For any particular cement the weight varies with the degree of heat in burning, the degree of fineness in grinding, and the density of packing. Other things being the same, the harder-burned varieties are the heavier. The finer a cement is ground the more bulky it becomes, and consequently the less it weighs. Hence, the light weight may be caused by laudable fine grinding or by objectionable under-burning.

"The weight per unit of volume is usually determined by sifting the cement into a measure as lightly as possible, and striking the top level with a straight edge. In careful work the height of fall is specified. The weight per cubic foot is neither exactly constant nor can it be determined precisely, and for the practical purpose of the user is of very little service in determining the value of a cement. However, it is often specified as one of the requirements to be fulfilled.

"The weight of Rosendale cement, determined by sifting the cement with a fall of three feet into a box having a capacity of one-tenth of a cubic foot, is 49 to 56 lb. per cubic foot. The difference in weight for any particular kind is mainly due to a difference in fineness.

"Ulster Co. Rosendale cement weighs 300 lb. per barrel net; Akron, Milwaukee, Utica and Louisville Rosendales weigh 265 lb. per barrel net." (Baker, Masonry Construction.)

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SIXTH SERIES OF QUESTIONS—SECTION OF 1909—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Name and describe the three grades of oil which are commonly used as the carburetting material in the manufacture of carburetted water gas.

2. Describe the operation of a direct fire furnace used for heating coal gas retorts, paying especial attention to the way in which the fire should be handled to secure the most economical results.

3. Give a description, illustrated with sketches, of one length of hydraulic main for benches of six retorts, including the dip pipes, overflow or overflows, arrangements for cleaning out heavy tar or pitch, and the considerations that determine the area of the surface of liquor in the main outside of the dip pipes.

4. Describe one, or more, of the various methods of construction that are employed to reduce to a minimum the damage resulting from an explosion in the blast pipe of a water gas apparatus, and explain how they act.

5. Give in British thermal units the heating power of a pound and of a cubic foot of each of the following gases:

Carbon	C
Hydrogen	H_2
Methane or Marsh Gas	CH_4
Ethylene or Olefiant Gas	C_2H_4
Carbon Monoxide	CO
Acetylene	C_2H_2
Benzene	C_6H_6
Ethane	C_2H_6

6. Give the formula by which the volume, measured at any pressure and temperature, of a gas saturated with moisture can be corrected to the standard conditions of a temperature of 60° F. and a pressure of 30 in. of mercury, and explain the manner in which this formula is derived.

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7. What are the different methods employed to determine the quantity of ammonia contained in ammoniacal liquor, and consequently the value of the liquor, and which gives the most accurate results?

8. In making meter connections the swivel of the meter union is by some inserted in the end of the lead pipe, the axes of pipe and swivel coinciding, while by others it is inserted in an opening made in the side of the pipe with its axis at right angles to that of the pipe. State, with the reasons for your answer, which method you consider best.

9. What are the different standard sizes of consumers' meters, and how many cubic feet of gas will each size of meter supply per hour?

10. Describe an Argand gas burner and state how it compares in efficiency from a light-giving standpoint with flat flame burners.

11. What are the relative carrying capacities for gas of a 3 in. main, a 4 in. main, and a 6 in. main, the conditions as to length of main, pressure lost by friction and specific gravity of the gas being the same in each case?

12. What are the characteristics of a good building brick, and how can a brick be tested to determine whether or not it possesses these characteristics?

(Answers to these questions are due July 1, 1907.)

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Answers to Sixth Series of Questions—Section of 1909 —Practical Class.—Trustees Gas Educational Fund.

Answers to questions Nos. 1 and 5 have been published in the previous volume of the Proceedings, and can be found there as follows:

No. 1, Vol. I., page 82.

No. 5, Vol. I., page 296.

The answers to the other questions are as follows:

2. Describe the operation of a direct fire furnace used for heating coal gas retorts, paying especial attention to the way in which the fire should be handled to secure the most economical results.

Ans. When a direct fire furnace is employed for heating coal gas retorts the carbon of the fuel is burned to carbon dioxide (CO_2) in one operation, which is practically completed in the fuel bed, and the retorts are heated principally by the sensible heat possessed by the products of combustion passing off from the fuel bed. It is therefore necessary to so handle the furnace as to produce the highest possible temperature in the fire itself. In fact, the fire should be handled very much the same as a boiler fire. The bed of fuel should not be made too deep, a depth of from 15 inches to 18 inches giving the best results. Fresh fuel should be added at frequent intervals, about once every hour, in order to maintain this depth constant and keep the fire from burning down too low. The grate bars should be shaken lightly from time to time so as to keep the bottom of the fire bright. The condition of this part of the fire can be determined by observing the reflection shown on the water in the ash pan. About 12 hours after the fire has been clinkered a slice bar should be run along the grate bars and the clinker that has formed there should be thoroughly broken up. Clinkering must be thoroughly done every 24 hours. It is impossible to use secondary grate bars when cleaning a furnace of this kind, and so after pushing as much of the fuel as

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possible up on the slope of the back wall the rest is dropped into the ash pan by drawing away the grate bars, the clinker is cut away from the side and back walls and removed from the furnace, the grate bars replaced, the fuel on the back wall drawn down and spread over the bars and fresh fuel charged into the furnace. The wear and tear on the furnace walls can be reduced by leaving an inch or so of clinker on them at all times, never attempting to take it off down to the brick.

To secure economy of fuel it is necessary to prevent any air from being drawn into the setting through cracks in the brickwork and openings around the frame of the charging door, and to be careful not to have an excessive draft. A direct fire furnace requires more draft to maintain the heat in the bench than does the generator furnace, but an excessive draft is bad in both cases. The appearance of flame at the top of the chimney flues indicates the existence of too much draft, and when it is noticed the dampers should be pushed in.

All flues should be carefully cleaned out at least once a month in order to prevent any stoppages in them that would interfere with the keeping up of the heat, such stoppages being very frequently the cause of low heats when everything is apparently in good order. (Trustees.)

3. Give a description illustrated with sketches of one length of hydraulic main for benches of six retorts, including the dip pipes, overflow or overflows, arrangements for cleaning out heavy tar or pitch, and the considerations that determine the area of the surface of liquor in the main outside of the dip pipes.

Ans. The hydraulic main for a bench of coal gas retorts should be made of wrought iron. The cross section shown on the accompanying cut is one of several that are in use. The length of a section would be just a little shorter than the distance between centres of the division walls on each side of the bench, and its width would be such as to give the necessary area of surface of liquor outside the dip pipes, the manner in which the area is determined being explained later.

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Circular holes are cut at the proper places in the top plate for the insertion of the dip pipes. These pipes must all be made exactly the same length from bottom of flange to lower end of pipe so that these ends will all be the same distance below the top plate, and will therefore all be sealed to the same depth when the main is set level.

The plate A serves to seal the space between it and the back plate B from the body of the main and thus permits the opening at any time of the cleaning lids, of which there are at least two to each length of main, for the drawing out of heavy tar which is too thick to run off through the tar pipe, without interfering in any way with the process of gas making. The same end may also be attained by making the body of the main U-shaped and attaching to it, on the back, cleaning pockets, the openings in the side of the main being made with their top edges below the water line to seal off the pockets from the main so that cleaning can be done at any time without interfering with gas making. The side of the main or of the pocket, as the case may be, along which the tar is to be drawn should be given a gradual slope in order to make it easier to draw out the heavy tar.

The overflows are arranged in various ways. Sometimes a single overflow opening from the bottom of the main is used to draw off both the tar and the ammoniacal liquor deposited in the main; in other instances only the liquor is drawn off by an overflow, the tar being run off at intervals through a drain pipe, while still another arrangement is to have two separate overflows, one for the liquor and the other for the tar. This last is the best arrangement, the objection to the single overflow for both tar and liquor being that it does not maintain a uniform seal on the dip pipes, while running off the tar at intervals entails a certain amount of labor that is avoided by the double overflow, so long as the tar is kept thin enough to run out of itself. Such an arrangement is shown on the cut. In every case the overflows should be made adjustable as to height so that the seal can be varied to suit different requirements. The adjustability is usually obtained by the use of nipples with long

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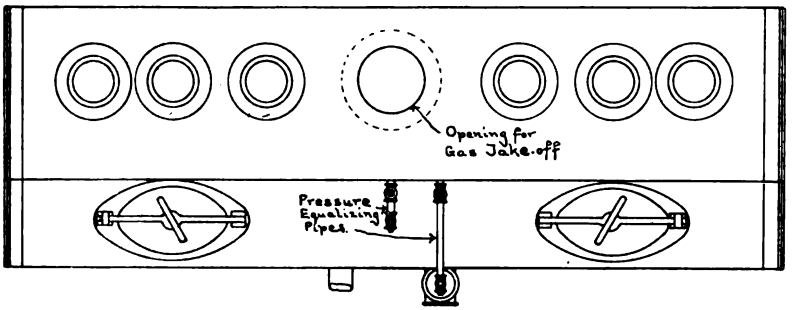
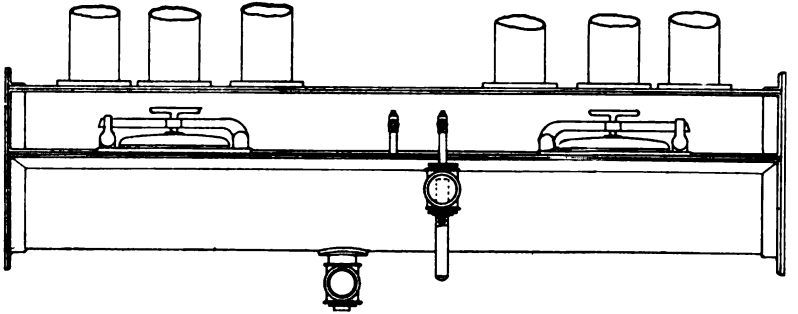
Plan.

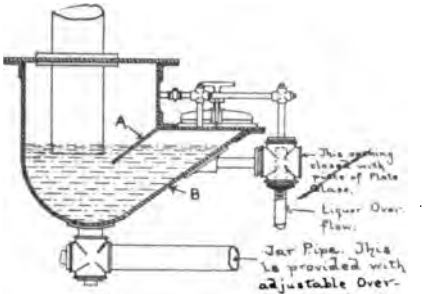




Elevation.

Hydraulic Main.

Bench of 6 Retorts.


A
B
This opening closed with plate of Plate Glass.
Liquor Over-flow.
Jar Pipe. This to be provided with adjustable Over-flow, similar to that on Liquor Pipe.

Section.

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threads which can be screwed up or down inside of a suitable fitting. For the liquor overflow a 1½-inch pipe screwing into a bushing set in one outlet of a 3-inch cross may be used. Special weir valves are also made for this purpose. When the overflow opens out of the main below the water level, as is often the case, a connection must be made between the gas space in the main and the space above the liquor in the portion of the overflow outside of the main, so that the pressure on the surface of the liquid in the main and that on the liquid in the overflow shall always be the same. Otherwise the main might be partially emptied of its liquid contents if a heavy pressure was thrown upon it by the stoppage of the exhauster or in any other way.

Each section of the hydraulic main must also be provided with a gas take-off of suitable size which connects it with the foul main.

The area of surface of the liquor outside the dip pipes is determined from the following considerations. It is necessary that the dip pipes should remain sealed when the retorts are open and the surface of the liquor in the dip pipes is subjected to atmospheric pressure, even when the pressure in the main is at the highest point it is likely to attain under the conditions existing in any given works. The unsealing of the dip pipes, when the water is at the proper level, can only be brought about by the forcing up into them of a volume of water equal to the area of the liquor in the main outside of the pipes multiplied by the distance from the normal surface of the liquor to the lower edges of the dip pipes, that is, of a volume equal to the surface area of the liquor multiplied by the normal depth of seal. If the depth of seal is taken as 1 inch, and the greatest pressure that is likely to be thrown on the main as 10 inches, it will be necessary to have the area in the main outside of the dip pipes a little more than ten times as large as the area inside of the pipes, since if it were less than this all the liquor outside the pipes above their lower edges would be forced up into them and they would thus be unsealed, before the height of liquor in them was sufficient to balance the pressure in the main. The

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rule may be stated in general terms as being that the area outside the dip pipes must always be at least as many times greater than the area inside the pipes as the quotient obtained by dividing the greatest pressure likely to exist in the main, by the normal depth of seal that it is the intention to carry. When the main is so designed there is no danger of gas passing back out of the dip pipes as long as the water is kept at the proper height in the main. (Trustees.)

4. Describe one, or more, of the various methods of construction that are employed to reduce to a minimum the damage resulting from an explosion in the blast pipe of a water gas apparatus, and explain how they act.

Ans. One method for reducing to a minimum the damage resulting from an explosion in the blast pipe of a water gas apparatus is to place at different points on the blast pipes relief valves which are loaded so that, while they remain tightly closed so long as the pressure in the blast pipe is at or below normal, they will be raised as soon as the pressure exceeds the normal. It is usual to place one of these relief valves on each of the elbows nearest to the valves governing the admission of the blast to the various parts of the apparatus. If an explosive mixture of air and gas is formed in the blast pipe during the run and exploded when the blow is put on, these valves are at once opened by the increase in pressure and afford a relief which, if the explosion is not too violent, will prevent injury to the blast pipe or blowers.

The same effect may be secured by having one section of blast pipe made very light so that it will give way and relieve the pressure before any damage is done to the stronger portions of the pipe. Duplicates of this light section are kept in stock and can be put in place very quickly so that gas making can be resumed in a short time after the explosion.

A third method is to put at every place at which the blast pipe changes its direction a tee with its free end pointing in the direction that would be followed by the explosive wave traveling back from the apparatus toward the blowers. The

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end of each tee is flanged and closed by a blind flange of tin bolted on with very light bolts. In case of an explosion these thin flanges are blown off before the pressure rises to a point high enough to damage the pipe, especially as they receive the full force of the wave as it travels along.

Another device which prevents the wave from traveling past a definite point in the blast pipe is called an explosion valve. It consists of a box set in and forming part of the blast pipe. This box is divided into two compartments by a partition at right angles to the axis of the blast pipe, and having in it a number of long, narrow horizontal openings, the spaces between the openings being faced on the side away from the blowers. Flaps made from leather or rubber belting backed with iron to give them weight and stiffness, are fastened by their upper edges on the side of the partition toward the apparatus in the spaces between the openings, so that each flap hangs in front of and covers an opening.

A pipe at least as large as the blast pipe leads from the top of the compartment nearest the apparatus to a convenient height above the ground, and its open flanged end is covered with a blind flange made of tin and bolted on by small stove bolts. As long as air is being driven through the pipe the flaps are kept off the partition plate and the air passes through freely, but when an explosion takes place, beginning, as it always does, at the apparatus, the wave traveling back along the pipe throws the flaps against the partition and closes off any communication with the part of the box on the blower side. At the same time the tin flange is blown off the top of the riser pipe and the pressure relieved. Such a valve furnishes an absolute protection against injury to the blowers. It should be located, if possible, just outside the generator house, but can be put inside of this house if necessary.

Various devices are employed to avoid explosions by preventing gas from accumulating in the blast pipe, but these do not come within the scope of the question. (Trustees.)

6. Give the formula by which the volume, measured at any pressure and temperature, of a gas saturated with moisture

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can be corrected to the standard conditions of a temperature of 60° F. and a pressure of 30 in. of mercury, and explain the manner in which the formula is derived.

Ans. The formula by which the volume, measured at any pressure and temperature, of a gas saturated with moisture can be corrected to the standard conditions of a temperature of 60° F. and a pressure of 30 in. of mercury is $V = \frac{17.64(h - a)v}{(460 + t)}$ in which V = the corrected volume at 60° and 30 in., v = the volume observed at a temperature of t° and a pressure of h in. of mercury and a = the tension of aqueous vapor at a temperature of t°.

This formula may be expressed in words as follows: The corrected volume of a gas saturated with water vapor at the standard conditions of 60° F. and 30 in. barometric pressure is equal to the observed volume multiplied by 17.64 times the difference between the observed barometric pressure and the tension of water vapor at the observed temperature, and divided by the sum of 460 and the observed temperature in Fahrenheit degrees. The tension of water vapor for the observed temperature must be found from the table giving the tensions for the different temperatures.

The formula is derived in the following manner:

Representing the volume at 60° F. and 30 in. pressure by V and that of the same mass of gas at any other temperature t and any other pressure h, by v, we can from the laws governing the change of volume of gases under the influence of changes in temperature and pressure derive the required formula for dry gases. Since the volume varies inversely as the pressure, the product obtained by multiplying the volume at any pressure by that pressure is equal to the product obtained by multiplying the volume of the same mass of gas at any other pressure by the corresponding pressure and we have,

$$30\,V = h\,v \text{ or } V = \frac{h}{30}\,v.$$

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Gases expand or contract $^1/_{492}$ part of their volume at 32° F. for each change in temperature of 1° F., hence the effect of temperature is shown by the equation $V(460 + t) = 520\,v$, since t is the number of degrees above 0, and, therefore, $460 + t$ is equal to 492, the number of parts at 32° F., plus one volume for each degree increase in temperature above 32° F., while 520 is the number of parts to which 492 parts at 32° will have expanded when the temperature is raised to 60°. From this we obtain the equation, $V = \frac{520\,v}{460 + t}$. Combining these two equations we have for dry gases $V = \frac{v \times h \times 520}{30\,(460 + t)}$, that is, the volume corrected to the standard conditions of 60° F. and a pressure of 30 in. of mercury is equal to the observed volume multiplied by the observed pressure in inches of mercury multiplied by 520 and divided by 30 times the sum of 460 and the observed temperature.

The correction for moisture depends on the fact that a gas saturated with water vapor, as will be a gas in contact with and over water, will under the same conditions of temperature and pressure always contain the same quantity of water vapor. This vapor exerts a certain pressure which increases with the temperature, and is proportional to the amount of vapor present. The pressure so exerted has been determined in inches of mercury for each degree of temperature. To correct for the presence of moisture in a gas saturated with water vapor it is necessary to deduct the pressure due to the tension of this vapor from the observed barometric pressure, since this barometric pressure is resisted partly by the pressure of the water vapor and partly by that of the gas, and therefore the pressure exerted on the gas will be really only the difference between the barometeric pressure and the pressure due to the tension of the water vapor. Calling this tension of water vapor a, and taking its value at the temperature of 60° (.518) to deduct from the standard barometric pressure of 30 in., we have for the formula for reducing the volume of gas saturated

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with water vapor observed at any temperature and pressure to that of gas saturated with water vapor at 60° and 30 in.,

$$V = \frac{(h-a) \times 520 \times v}{(30 - .518) \times (460 + t)} = \frac{(h-a) \times 520 \times v}{29.482 \ (460 + t)}$$

or dividing both numerator and denominator of the fraction by 29.482

$$V = \frac{17.64 \ (h-a) \ v}{460 + t}$$

(Trustees.)

7. What are the different methods employed to determine the quantity of ammonia contained in ammoniacal liquor and consequently the value of the liquor, and which gives the most accurate results?

Ans. The most common and at the same time the least accurate method of determining the quantity of ammonia contained in any given sample of ammoniacal liquor, is to ascertain the specific gravity of the liquor by means of Twaddel's hydrometer, and then calculate the content of ammonia on the assumption that each degree Twaddel is equivalent to a strength of two ounces. This method is only approximately correct at best, and is far from accurate if the liquor contains any uncombined ammonia, since the greater the amount of such ammonia contained in the liquor the lower will be its specific gravity, and consequently the lower its value as indicated by the hydrometer.

A second method which is also more or less inaccurate, according to the composition of the liquor, is to add sulphuric acid to a measured quantity of the liquor until the ammonia is just neutralized, the strength of the acid and the quantity of liquor being so chosen that the results are the same as if pure acid and a gallon of liquor had been taken, and, the quantity of acid used being accurately measured, calculate the amount of ammonia neutralized from this quantity. The source of error in this method is found in the fact that the "fixed" ammonia salts dissolved in the liquor are not affected by the sulphuric acid,

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therefore, no acid is used in neutralizing the ammonia contained in these salts, and this ammonia is not included in the amount credited to the liquor. In fact, according to Mr. H. L. Greville, in a series of tests made by him, an average of 22.5 per cent. of the ammonia present in the liquors was not indicated by this method of testing.

The most accurate method of determining the true value of ammoniacal liquor is that which is known as the Wills or distillation test. In this a measured quantity of the liquor is mixed with a caustic alkali, usually soda, and then exposed to a strong heat for one or two hours. The soda combines with the acids of the ammonia salts in the liquor, setting free all the ammonia contained in the liquor. This ammonia passes off in the gaseous state and is absorbed in a solution of sulphuric acid, the amount of acid neutralized being accurately determined. As in the saturation test, the quantity of liquor and the strength of the acid used in the test are so chosen that the results can be read off in terms of ounces of ammonia per gallon of liquor. This test gives an exact determination of the amount of ammonia contained in a liquor, and is the one which should be employed in all cases in which it is necessary to determine the value of a liquor as between buyer and seller. (Trustees.)

8. In making meter connections the swivel of the meter union is by some inserted in the end of the lead pipe, the axes of the pipe and swivel coinciding, while by others it is inserted in an opening made in the side of the pipe with its axis at right angles to that of the pipe. State, with the reasons for your answer, which method you consider best.

Ans. It is better to insert the swivel in the end of the lead pipe making what may be called a straight connection, rather than to insert it in the opening cut in the side of the pipe making a "shoe connection," as it is sometimes called.

The straight connection is much stronger than the "shoe connection." This follows from their respective methods of construction. The swivel when inserted in the end is fastened

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to the pipe and held by it along a much greater length than when it is inserted through the side, consequently it is held more firmly and is able to stand a greater strain without breaking the joint and causing a leak.

The swivel being simply a continuation of the pipe the straight connection affords a freer passage for the gas. Unless the "shoe connection" is very carefully made the swivel is apt to be pushed so far into the pipe that it seriously obstructs the passage of the gas even when it is not intentionally pushed far in to secure greater strength. If the hole in the pipe is not cut to the proper size and shape there is also danger of solder running down into the pipe and partially blocking it. The tight fit between the pipe and the swivel in the straight connection prevents any such running down of solder into the pipe. Any obstruction, whether caused by the swivel or by solder, has a tendency to give rise to a deposit of naphthalene in the connection. Even if perfectly made the shoe connection causes the gas to change the direction of its travel very abruptly, and thus throws more pressure than the straight connection in which the change in direction is never more sudden than that caused by the use of an ell.

The straight connection requires the use of less labor and material in the making than does the shoe connection, since it is not only easier to expand the end of the pipe for the insertion of the swivel than it is to cut a hole out of its side, but in the shoe connection the end of the pipe must also be closed up and soldered together to ensure its tightness.

One claim that is made for the shoe connection is that it is very convenient when meters have to be set close to the ceiling, but even in such cases it is possible to make the connection in other ways that are stronger and more workmanlike, and there is therefore no real reason in favor of this form of connection. (Trustees.)

9. What are the different standard sizes of consumers' meters, and how many cubic feet of gas will each size of meter supply per hour?

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Ans. The standard sides of consumers' meters are

3	light	60	light
5	"	80	"
10	"	100	"
20	"	150	"
30	"	200	"
45	"	250	"

300 light

The volume of gas that will pass through a meter in a given length of time depends, among other things, upon the pressure lost in the meter, that is the difference between the pressure of the gas at the inlet and the pressure at the outlet. There is no general agreement as to the amount of pressure that it is permissible to allow the meter to absorb. Mr. C. W. Hinman, in a paper on the "Measurement of Gas," read before the New England Association of Gas Engineers, says that when the meter is measuring gas to be used for illuminating purposes a loss of $^4/_{10}$ in. is as large as should be permitted, since any larger loss would cause a fluctuation in the pressure at the outlet, due to the working of the meter, of sufficient magnitude to show on the flames. Many engineers set the limit at $^5/_{10}$ in., while on the other hand some do not think that the loss should exceed $^3/_{10}$ in.

Meters made by different makers differ from each other in the amount of gas passed for the same loss of pressure although rated as being the same size. The figures given in the following table are the average capacities per hour determined from tests of meters of each size from a number of different makers.

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Size	Capacity with loss of pressure of $\frac{3}{10}$ in. cu. ft.	Capacity with loss of pressure of $\frac{4}{10}$ in. cu. ft.
3 light	40	55
5 "	50	75
10 "	80	120
20 "	115	160
30 "	175	270
45 "	215	315
60 "	330	475
100 "	385	600
150 "		1015
200 "		1380
300 "		1635

It is generally assumed that it is safe to connect to a meter, burners with a greater total capacity than that of the meter, because it is not probable that all the burners will be lighted at any one time, but it is not wise to take too much risk along this line. (Trustees.)

10. Describe an Argand gas burner and state how it compares in efficiency from a light giving standpoint with flat flame burners.

Ans. The Argand burner is a luminous flame burner in which the gas is burned in an annular flame with separate air supplies for the interior and the exterior surfaces of the flame. The flame is surrounded by a glass chimney. The burner tip is in the form of a hollow cylindrical annulus with a round top which is perforated with a number of small circular holes spaced so closely together that the jets of gas issuing from them coalesce into a solid ring of flame. In the best form of Argands this tip is formed of steatite or some similar substance, which has the advantages over metal of being a non-conductor of heat and of not being subject to corrosion, and therefore allows the attainment of a higher flame temperature and of a longer life for the burner than is possible with a metal tip. In the centre of the interior air opening is placed a narrow metal spike, like a piece of very thick wire,

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the object of which is to steady the interior air current and give it a direction of travel parallel to that of the gas. The external air supply is divided into two parts by the use of a frustrum of a hollow cone made of metal which surrounds the tip for its full height. The largest portion of the air supply for the exterior surface of the flame comes into the chimney on the inside of this cone and is directed by it upon the base of the flame, but as the bottom of the cone does not reach quite to the base of the chimney another portion of this air supply enters between the cone and the chimney and ascends next the chimney to supply the upper part of the flame. The gas is supplied to the gas chamber in the tip by three small supply pipes spaced at equal distances around the circle, the combined area of the openings in these pipes being less than that of the opening in the fixture on which the burner is screwed. The number of holes in the tip may be varied so long as their size is kept such as is suitable to the quality of the gas to be consumed, and their combined area is larger than that of the openings in the pipes through which the gas reaches the tip.

The draft of the chimney used with an Argand burner furnishes a motive force by which the air required for combustion is drawn into the flame and the gas is not required to exert any injector action to accomplish this object, nor is it necessary to have any great velocity of exit from the burner orifice to give the proper shape to the flame. It is therefore possible to have the gas flow from the holes in an Argand burner at practically no pressure, and since the air supply can be very closely regulated by varying the height and size of the chimney used, it is possible to secure very good conditions for luminous combustion in an Argand burner, and consequently these burners give much better illuminating power results from the grades of gas for which they are designed than do the flat flame burners. They are made principally for use with gas with an illuminating value of under 20 candles, and when the gas has a candle-power greater than this the Argands in common use are not fitted for its consumption and do not give any better results than, or even as good results as, good flat flame burners, although if Argand burners were made espec-

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ially for such gas there is no reason why the results should not be relatively as good as those obtained with the gas of lower grades. (Trustees.)

11. What are the relative carrying capacities for gas of a 3 in. main, a 4 in. main, and a 6 in. main, the conditions as to length of main, pressure lost by friction, and specific gravity of the gas being the same in each case?

Ans. The formula by which the amount of gas flowing through pipes under different conditions can be calculated is $Q = 1350 \sqrt{\frac{d^5 p}{sl}}$ in which Q is the number of cubic feet of gas delivered per hour, d is the diameter of the pipe in inches, p is the pressure required for overcoming the friction in the pipe, s is the specific gravity of the gas, and l is the length of the pipe in yards. From this formula it will be seen that the amount of gas delivered will, everything else remaining the same, vary as the square root of the fifth power of the diameter of the pipe in inches. The fifth power of 3 is 243, and the square root of this is 15.59; the fifth power of 4 is 1,024, and the square root of this is 32; the fifth power of 6 is 7,776, and the square root of this is 88.18. Therefore the carrying capacities of 3 in., 4 in. and 6 in. pipes are to each other, all other conditions being the same, as 15.58 to 32.00 to 88.18, or as 1 to 2.05 to 5.66. That is, a 4 in. pipe will carry 2.05 times as much gas as a 3 in., and a 6 in. will carry 5.66 times as much as a 3 in., and 2.76 times as much as a 4 in. The same relation holds for pipes of any diameters that bear the relation of 3, 4 and 6 to each other. Thus an 8 in. pipe will carry 2.05 times as much as a 6 in., and a 12 in. 5.66 times as much as a 6 in. and 2.76 times as much as an 8 in. (Trustees.)

12. What are the characteristics of a good building brick, and how can a brick be tested to determine whether or not it possesses these characteristics?

Ans. Baker's Treatise on Masonry Construction, page 37, contains the following paragraph: "Requisites for Good

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Brick. 1. A good brick should have plane faces, parallel sides, and sharp edges and angles. 2. It should be of fine, compact, uniform texture; should be quite hard, and should give a clear ringing sound when struck a sharp blow. 3. It should not absorb more than one-tenth of its weight of water. 4. Its specific gravity should be two or more. 5. The crushing strength of half brick, when ground flat and pressed between thick metal plates, should be at least 7,000 pounds per square inch."

Regularity of shape can be determined by inspection of the brick, as can also, to a certain extent compactness and uniformity of texture. The absorptive power, which affects the durability of the brick, especially as regards its resistance to frost, can be determined by weighing the brick after it has been kept exposed in a room under ordinary atmospheric conditions for a week, and then again after it has been immersed in water for from 40 to 48 hours and allowed to dry until all the water on the surface has evaporated, the difference between the second weight and the first one being the weight of water absorbed. The smaller the amount of water so absorbed the greater will be the durability of the brick.

In determining the crushing strength of the brick different methods are followed. Sometimes half brick are tested and sometimes whole ones. In some cases the surfaces to be subjected to the pressure are ground accurately to planes parallel to each other, while in other cases the surfaces are leveled up by putting on a thin coat of plaster of paris, and in still others the bricks are put into a testing machine in the rough state. The best practice is to either grind the faces or level them up by the use of plaster of paris, so that the pressure is applied equally all over the surface. These crushing tests are usually made in a hydraulic press provided with cast iron pressing surfaces which are self-adjusting.

The test for transverse strength is about the most valuable that can be given to brick to determine its practical value. It is made by supporting the brick on two supports with thin edges placed the required distance apart and then loading it in the centre with a load which is applied by a beam with a

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thin edge bearing on the brick, the load required to break the brick being carefully determined. The modulus of rupture as determined by this test should be at least 1,000 pounds per square inch. (Trustees.)

TENTH SERIES OF QUESTIONS—SECTION OF 1908—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. State the nature of the material to be employed and the points of valve design that should be observed in the pump end of a steam pump for handling tar.

2. Describe some method by which accumulation of naphthalene may be completely removed from the inlet pipes of gas holders.

3. How would you determine, approximately, the weight of water evaporated per pound of fuel by a boiler under ordinary working conditions?

4. Describe the proper treatment of iron oxide from the time it is taken out of the box for revivification until it is again returned to the box.

5. What is the maximum amount of gas containing 0.75% by volume of H_2S that can theoretically be purified at one exposure by a bushel of iron sponge, or mass, which contains an amount of $Fe_2O_3H_2O$, equivalent to a weight of 23 lb. of iron? It is assumed that no oxygen is present in the gas. Give the reaction, or reactions, upon which you base your figures, and also give your calculations.

6. Calculate the maximum theoretical flame temperature that can be produced when Hydrogen, H_2, Marsh Gas, CH_4, and Olefiant Gas, C_2H_4, are burnt in air.

7. What effect does the saturation of a gas with one vapor have upon the amount of other vapors that can be carried by the gas?

8. What is meant by "The Mechanical Equivalent of Heat," and what is its value expressed in foot pounds per heat unit (British thermal unit)?

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9. The amount of gas unaccounted for during distribution is expressed sometimes as a percentage of the quantity made and sometimes in terms of the number of thousand cubic feet unaccounted for per mile of main per year. Which method of expression furnishes the best indication of the condition of the distributing system and the best basis for comparisons between different companies and different periods in the history of the same company?

10. Describe some method of coating wrought iron pipe, such as is used for services, or some other way by which this pipe can be protected from corrosion.

11. What is the so-called "Otto cycle" in gas engines?

12. What are the respective merits of concrete and brick work as the material to be employed in the construction of the walls of gas holder tanks?

(Answers to these questions are due Aug. 1, 1907.)

ANSWERS TO TENTH SERIES OF QUESTIONS—SECTION OF 1908 —PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

Answers to questions Nos. 7, 8 and 11 are included among the answers to the eleventh series of questions for the section of 1907, in this volume. Answers to questions Nos. 3, 4 and 5 have been published in the previous volume of the Proceedings. These answers can be found as follows:

No. 3, Vol. I., page 108.
No. 4, Vol. I., page 117.
No. 5, Vol. I., page 119.
No. 7, Vol. II., page 91.
No. 8, Vol. II., page 93.
No. 11, Vol. II., page 101.

The answers to the other questions are as follows:

1. State the nature of the material to be employed and the points of valve design that should be observed in the pump end of a steam pump for handling tar.

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Ans. All the parts of the pump end of a steam pump for handling tar should be made of iron since the ammoniacal liquor, more or less of which is always mixed with the tar, would rapidly eat away any brass or composition which might be used for the cylinder lining or the valves.

The principal points of valve design to be observed are that the valves should afford full, free openings, and that the seats should be so arranged that no lumps of heavy tar or of solid matter in the tar will lodge on them and prevent the valves from closing tightly. A hinged valve is better than the ordinary form of pump valve, since in the latter form the centre guide obstructs the opening to a great extent, while the hinged valve affords a free and unobstructed opening. These valves are sometimes used with horizontal seats and sometimes with seats inclined at an angle of 45°. With the inclined seat there is less danger of any solid matter remaining on the seat and keeping the valve open.

A firm which handles a great deal of tar employs pumps in which the valves are hinged and the seats horizontal, and say that they have found them to give good satisfaction. In this case the valves are not provided with springs, being prevented from opening too far by stops and being closed by their own weight as soon as the pressure is removed from beneath them. In other pumps, springs are used with the same kind of valves to keep them from opening too far and to assist in closing them promptly when the plunger changes the direction of its travel. These springs should be made of iron or steel. (Trustees.)

2. Describe some method by which accumulations of naphthalene may be completely removed from the inlet pipes of gas holders.

Ans. Accumulations of naphthalene in the inlet pipes of gas holders occur most frequently in that portion of the pipe which passes down under the tank wall and up inside the holder. When the naphthalene exists in the pipe as a flocculent lining of approximately uniform thickness throughout a large portion of its length it can be removed by charging the gas with the

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vapor of light naphtha, gas so charged being able to pick up naphthalene deposited in the form of loose crystals. The gas can be charged with the vapor either by injecting the naphtha into the inlet pipe in the form of a spray by means of a steam jet, or by filling the drip at the bottom of the pipe with naphtha which gradually evaporates into the gas passing over it. Naphthalene in the condition named can also be removed by blowing steam into the pipe in sufficient quantity to raise the temperature to the point at which the naphthalene will either melt and run down into the drip, from which it can be pumped out, or vaporize and be taken up by the gas. In all of these methods it is necessary to have gas flowing through the pipes so that the naphthalene as it is vaporized will be picked up by the gas and carried along with it out of the pipe, and there is always danger that the naphthalene so picked up will be again deposited at an inconvenient point during the further travel of the gas. When naphtha vapor is employed this will condense at the same time that the naphthalene is deposited, dissolve the latter and carry it along to the nearest drip, thus preventing any obstruction, but when steam is used the liability is great that the obstruction will be merely transferred from one point of the pipe system to another.

In many cases the presence of naphthalene is not suspected until it has formed, on the inside of the portion of the pipe which rises through the water in the tank, a layer of such thickness that it is detached from the sides of the pipe by its own weight and falls into the elbow making the turn from the vertical into the horizontal part running under the tank wall, where it forms a compact mass. Such a mass seems to be very little affected by either naphtha vapor or steam, and must be washed out either with hot water or with naphtha in the liquid form. Hot water may be used in several ways. At one works, the water, heated by means of steam in an old boiler equipped for the purpose, the pressure being run up to between thirty and forty pounds per square inch, was conducted to the holder by a temporary line of pipe. The operation of cleaning out the holder inlet was carried on as follows: The holder was practically emptied of gas, the time chosen

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being that when the stock of gas was small enough to be contained in the other holders, and kept so as long as possible, though this was merely to keep the weight of pipe to be handled at a minimum, as the holder could be raised through the outlet pipe without interfering with the work. Through a hole drilled in the top of the bonnet over the inlet pipe was inserted a one-inch pipe on the bottom of which was screwed a 1 in. by ½ in. ell, the direction in which this ell pointed being marked on the pipe at the top. This pipe was made long enough at the start to reach down to the bottom of the holder inlet and a number of short pieces of pipe were provided to screw on as the holder rose. The pipe fitted loosely in the hole in the bonnet, but a practically gas-tight joint was made by wet cloths wound round the pipe at this point. The pipe was supported and turned by means of a bar handle clamped on at the proper height. A hose connection being made between this pipe and that from the hot water heater and the water being turned on, it issued from the opening in the ell in a jet, which broke up and dissolved the naphthalene, and ran down into the drip, from which it was pumped, bringing the naphthalene with it both in solution and in suspension. The drip pump was kept working all the time the water was being run in, so that the water should be pumped out before it cooled down and dropped the naphthalene. The water pipe being turned so that the stream played against all parts of the inlet pipe, a very complete cleaning could be given by this method.

Another method for washing out the naphthalene is called "plunging." In this the inlet pipe is sealed with water, the flange at the top of the vertical pipe outside the holder taken off and the drip pump removed. The pipe is then filled as full of hot water as it is possible to have it without filling up the horizontal run coming to the holder from the station meter. A plunger, or wooden cylinder about eighteen inches to two feet long and a little smaller in diameter than the pipe, fastened to a pipe handle, the axis of the pipe and the cylinder coinciding, is then inserted and worked up and down so as to impart a surging motion to the whole body of water. The surging back and forth of the water dislodges the naphthalene that is

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not dissolved and the large pieces rising to the surface are fished out, the remaining fine particles being pumped out with the water. It is rather a difficult matter to get the large body of water contained in pipes above 16 in. in diameter moving with sufficient velocity to dislodge the compact masses of naphthalene, but if the motion can be produced, "plunging" is a very effective method for the removal of naphthalene from the pipes.

When naphtha or any other liquid solvent is used it is not economical to pour it into the pipe by itself, since, if this is done, it will cut channels in the deposit through which it will run to the drip before it is fully saturated with naphthalene. A better effect can be obtained by pouring water into the inlet until it is filled to half its height. Then from four to five gallons of solvent naphtha are poured in, and the water slowly pumped out at the drip, so that the liquid gradually falls in the main. The consequence is that the solvent, which forms a layer on the top of the water, is forced to act on the whole of the interior surface of the main, both where the latter is upright and where it is nearly horizontal. The time during which it acts on the surface is determined by the rate of pumping, and thus may be made sufficiently long to complete the solution of the naphthalene. When the solvent has reached the elbow, the rate of pumping is diminished in order to give it time to act on the greater horizontal section of the pipe which then becomes exposed to it. By this method of treatment the whole of the inner surface of the pipe is freed from naphthalene, which is completely removed from the main through the pump. (Trustees.)

6. Calculate the maximum theoretical flame temperature that can be produced when Hydrogen, H_2, Marsh Gas, CH_4, and Olefiant Gas, C_2H_4, are burnt in air.

Ans. According to the answer to question No. 9 of the Ninth Series the maximum temperature that can be produced by burning a gas in air can be determined by dividing the calorific value of the gas, per pound, by the sum of the numbers obtained by multiplying the weight of each of the products of combustion from 1 lb. of gas by its proper specific heat, the

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nitrogen mixed in the air with the oxygen required for combustion being considered as one of the products of the combustion. For gases containing hydrogen the net calorific value must be taken, since it is evident that the water produced by the combustion of the hydrogen will pass off as vapor.

The values at ordinary temperatures of the specific heats at constant pressure of the products of combustion are often used in determining the maximum flame temperatures that can be obtained, but this is not strictly correct, because the specific heats of gases increase with the temperature and therefore the use of the specific heats at ordinary temperatures makes the calculated temperatures too high. The specific heats of the ordinary products of combustion are given, for a wide range of temperatures, in the table which forms part of the answer to question No. 9 of the Ninth Series.

Applying the rule previously given to the different gases named in the question, the following results are obtained: The net calorific value of 1 lb. of hydrogen is 52,038 B.t.u.; and the products of its combustion are 9 lb. of aqueous vapor and 26.48 lb. of nitrogen, as given in the answer to question No. 8 of the Sixth Series. Assuming a flame temperature of 3452° F. it is found from the table that the mean specific heat of water vapor for this temperature is 0.732 and that of nitrogen 0.323. This gives for the fraction from which to determine the flame temperature

$$\frac{52038}{9 \times 0.732 + 26.48 \times 0.323} = \frac{52038}{6.588 + 8.553} = 3437° \text{ F.}$$

Adding to this 60°, which is the normal temperature of the atmosphere, will give a flame temperature of 3497°. The maximum flame temperature that can be produced by the combustion of hydrogen and air may therefore be taken as being in round numbers 3500° F.

The net heating power of 1 lb. of Marsh Gas (CH_4) is 21,502 B.t.u.; and the products of its combustion are 2.25 lb. of aqueous vapor, 2.75 lb. of carbon dioxide and 13.24 lb. of nitrogen. Assuming a flame temperature of 3092° F. the table gives the mean specific heats for this temperature as carbon

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dioxide 0.342, water vapor 0.700 and nitrogen 0.314. The fraction from which to determine the flame temperature is therefore

$$\frac{21502}{2.75\times0.342+2.25\times0.7+13.24\times0.314}=\frac{21502}{0.840+1.575+4.1574}$$

$$=\frac{21502}{6.5724}=3272^\circ \text{ F.}$$

Adding 60°, in this case will give a flame temperature of 3332°, but the difference between the assumed and calculated temperatures is too great, so it is necessary to assume another temperature. Taking this as 3272° the mean specific heats are carbon dioxide 0.351, water vapor 0.716 and nitrogen 0.318. The fraction for the flame temperature thus becomes

$$\frac{21502}{2.75\times0.351+2.25\times0.716+13.24\times0.318}=\frac{21502}{0.965+1.611+4.21}$$

$$=\frac{21502}{6.786}=3169^\circ.$$

Adding 60°, gives a flame temperature of 3229° F. This is only 43° lower than the assumed temperature, which is within the limits of error for the table of specific heats.

The net calorific value of 1 lb. of Olefiant Gas (C_2H_4) is 20,461 B.t.u.; and the products of its combustion are 1.29 lb. of aqueous vapor, 3.14 lb. of carbon dioxide and 11.35 lb. of nitrogen.

Assuming a temperature of 3542° F. and interpolating for the mean specific heats, these are found to be, carbon dioxide 0.364, water vapor 0.74 and nitrogen 0.325. The calculated temperature is therefore to be found from the fraction

$$\frac{20461}{3.14\times0.364+1.29\times0.74+11.35\times0.325}=\frac{20461}{1.143+0.955+3.689}$$

$$=\frac{20461}{5.787}=3535^\circ.$$

Then $3535^\circ+60^\circ=3595^\circ$ F., which is near enough to the assumed temperature to be allowed to stand.

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The flame temperatures of any other gases can be found in the same manner. (Trustees.)

9. The amount of gas unaccounted for during distribution is expressed sometimes as a percentage of the quantity made and sometimes in terms of the number of thousand cubic feet unaccounted for per mile of main per year. Which method of expression furnishes the best indication of the condition of the distributing system and the best basis for comparison between different companies and different periods in the history of the same company?

Ans. The method of expressing the amount of gas unaccounted for in terms of the number of thousand cubic feet unaccounted for per mile of main per year furnishes a better indication of the condition of the distributing system and a better basis for comparison between different companies and between different periods in the history of the same company than does the expression of this amount as a percentage of the total amount of gas made. The amount of gas sold per mile of main varies so much with different companies that the relation borne by the amount of gas unaccounted for to the total amount made, may be smaller in the case of a company with a compact district than it is in the case of a company with a sparsely settled territory, even though the distribution system of the latter company is in better condition, as shown by the loss of gas per mile of main, than that of the former. Take, for instance, two companies each selling 50,000,000 cubic feet of gas per year, and showing unaccounted-for gas amounting to 5,000,000 cubic feet; one of which has twenty miles of mains and the other sixty miles, the number of meters in use being approximately the same for the two companies. On a percentage basis the two would show the same figures, 10%, for unaccounted-for gas, but, as a matter of fact, the company that shows a loss of 5,000,000 cubic feet on twenty miles of main, or 250,000 cubic feet per mile of main per year, is not doing as well as the one that only shows a loss of 5,000,000 cubic feet on sixty miles of main, or 83,333 cubic feet per mile per year. The unaccounted-for gas is not made up entirely of gas lost by

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actual leakage from the mains, being partly due to differences in temperature between the station meter and the consumers' meters and also to inaccuracies of registration on the part of the consumers' meters, but the amount due to these causes would be practically the same in each case, provided the same attention was paid to the testing and repair of the consumers' meters and the maintenance of a proper temperature at the station meter, and the amounts lost by actual leakage would bear to each other very nearly the same proportion as the total amount of the unaccounted-for gas. Therefore, in the instance assumed, the distributing system of the company with sixty miles of mains is really in much better condition than that of the company with twenty miles, although the percentages of gas unaccounted for are the same. To make the comparison perfectly accurate, the lengths of the different sizes of mains should be reduced to the equivalent length of, say, 3-in. main before the division is made.

For comparisons between different periods in the history of the same company, the percentage system is only correct as long as the sales of gas per mile of main remain about the same. When the sales change decidedly, a decrease in the percentage may coincide with an increase in the amount of actual loss. If, for instance, the company with sixty miles of main increased its sales to 100,000,000 cubic feet per year while its main mileage was increased to sixty-five miles, a loss of 8% would amount to 8,000,000 cubic feet per year, equal to 118,000 cubic feet per mile of main, as against a loss of only 83,000 cubic feet when the percentage was 10.

There are, of course, cases where conditions are so different that even the loss per mile of main per year does not afford a basis for accurate comparisons, but, as a general rule, the conditions which affect the accuracy of such a comparison do not vary as much as do those which affect that of the comparison on the percentage basis. (Trustees.)

10. Describe some method of coating wrought iron pipe, such as is used for services, or some other way by which this pipe can be protected from corrosion.

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Ans. The method of coating service pipes that seems to have given the best results, is that which was first employed in Cincinnati after a series of tests made with a number of different coatings. The specifications for this coating are given, and the manner in which it should be applied to the pipes to give the best results is described in a "Short Topic" prepared by Mr. A. C. Humphreys for the 1895 meeting of the American Gas Light Association and published in Vol. XIII of the Proceedings, page 186.

The specifications are as follows: "Bring a kettle of tar (20 gallons) to a low boiling point and add 20 pounds of fresh slaked lime, sifted over the top and worked down. Boil down to a paste or a consistency about midway between tar and pitch. Let it settle for a few minutes, then add 4 pounds of tallow and 1 pound of powdered rosin; stir until they are thoroughly dissolved and incorporated with the tar, then let it cool and settle. Ladle off into barrels. When ready for use, to each barrel of 45 gallons of the above mixture add 4 pounds of crude rubber, dissolved in turpentine to the consistency of thick cream. Heat the mixture to about 100° Fahrenheit, and immerse the service pipe, heated to about the same temperature."

Different methods have been adopted for applying this mixture, the pipes being dipped in some cases and painted in others. Mr. Humphreys said that the best method was to dip the lengths of pipe into the preparation. In this method the mixture is put into a V-shaped trough which is long enough to take the longest length of pipe that is apt to be handled. Along the bottom of this trough is run a steam pipe to heat the mixture to the proper temperature. The pieces of pipe to be coated must also be heated, which can be done either by connecting the pieces to a steam pipe and turning steam on them to give them a test for soundness while they are being heated, or by putting them in a long square box with a hinged cover, the interior of the box being kept hot by means of a steam coil run along the bottom. When the pipes are heated to the proper temperature, they are plugged at both ends to prevent any of the coating from getting on the inside, and are dropped into

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the hot mixture in the trough. After a few minutes they are taken out, placed on a rack over the trough until the excess of the mixture has dropped off, and then transferred to a drying rack in which they are left until the coating has become thoroughly dry and hard. Care must be taken to keep the pieces from touching each other before they are dry, since, if this is not done they will stick together, and when pulled apart the coating will stick to one pipe and a bare place will be left on the other. Care must also be taken not to get either the mixture or the pipe too hot, since overheating will drive off the more volatile portions of the preparation, and when the coating cools, it will be brittle and liable to chip off. If the proper precautions are taken and fresh portions of the mixture added from time to time to that already in the trough, the coating will be elastic and will cling very tightly to the pipe. The service gang should, however, be supplied with a pot of the preparation so that after the service is laid, the spots where the coating has been scraped off by the tools can be re-coated before filling in the ditch. In some cases the pipe, as it lies in the ditch, is covered for its whole length with an extra layer of the coating, which forms a roof over it.

It will be found rather difficult to dissolve the rubber, but this part of the specifications must not be slighted. Given proper care in the preparation and application of this coating, the pipe covered with it will last much longer than uncoated pipe, and the cost of coating will be more than repaid by the extra life of the services and the lower leakage account. (Trustees.)

12. What are the respective merits of concrete and brick work as the material to be employed in the construction of the walls of gas holder tanks?

Ans. As a material to be employed in building the walls of gas holder tanks, concrete possesses the following advantages over brick work: Its tensile strength is greater and can moreover be easily increased by embedding in the tank wall, as it is built up, rings of hoop iron which may be placed from four to six inches apart horizontally and from five to six feet apart ver-

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tically. This greater tensile strength reduces the liability of cracking when the nature of the soil is such as to make it difficult to secure a good earth backing for the wall. A tank can be built of this material without the aid of any but comparatively unskilled labor under proper supervision. It can be made water-tight of itself, by the use of materials free from loam or dirt and the exercise of proper care in mixing and placing in position, while it is almost impossible to build a brick wall that will be water-tight of itself, and in any case the concrete tank can be made tight either by a backing of clay puddle or by rendering with cement as easily as can the brick tank. As a general thing concrete is cheaper than brick work, and this is especially the case when cheap broken stone or gravel, or an accumulation of old retort material or bricks are available for aggregate. Well made concrete is not as much affected by exposure to the weather as is even the best brick work, and therefore a concrete tank will not be subject to as much wear at the water line as a brick one. Altogether, unless bricks are cheap and the material for the aggregate of concrete dear, concrete is the best material to use for the walls of holder tanks, where the conditions are such as to permit the economical construction of a masonry tank.

Concrete is used for tank walls much more frequently in England than in this country. Mr. N. H. Humphrys, writing of Large Gas Holders in England (American Gas Light Journal, Vol. LXX, May 29, 1899, page 803) says: "The next direction in which progress has been made is the substitution of cement concrete for brick work, which means a large saving both of material and labor, together with increased strength. Concrete is not only easy of erection, requiring no skilled labor, but it is also stronger than brick. It offers every facility for the incorporation, within its substance, of iron bands, and concrete strengthened with iron ties is in some respects a perfect material. The iron being enclosed is preserved from corrosion or changes of temperature, and we have the weight and rigidity of the masonry tank, combined with the strength of the iron tank, without the inelastic brittleness of the one and the contraction and expansion of the other. Gas works are con-

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tinually producing large quantities of hard clinker, broken brick, old retorts, etc., that are very suitable for aggregate, but which only realize low prices if offered for sale. By exercising a little foresight, sufficient material can be saved up in the course of a few years to supply all that is wanted." (Trustees.)

THIRD SERIES OF QUESTIONS—SECTION OF 1910—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Name the principal gas coal fields of the United States and Canada, and give the general characteristics of the coal from each field.

2. Give a description, illustrated with sketches, of a retort mouthpiece, showing the manner in which it is fastened to the front of the retort and the arrangement for making a gas-tight joint between the mouthpiece and the lid.

3. Describe the operation of a carburetted water gas apparatus of the generator-superheater type during its regular working, including in the description an account of how to handle the various blast valves so as to bring the different parts of the apparatus to the proper temperatures simultaneously and without any waste of fuel.

4. Two samples of illuminating gas have the respective compositions given below. Calculate the weight per 1,000 cubic feet and the specific gravity of each sample.

		SAMPLE NO. 1.	SAMPLE NO. 2
Carbon Dioxide,	CO_2	1.8%	2.2%
Oxygen,	O_2	0.4	0.8
Ethylene,	C_2H_4	3.8	13.7
Carbon Monoxide,	CO	7.5	29.9
Hydrogen,	H_2	49.0	33.5
Marsh Gas,	CH_4	33.5	13.4
Ethane,	C_2H_6	0.9	2.9
Nitrogen,	N_2	3.1	3.6
		100.0	100.0

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5. The answer to Question No. 5, Second Series, shows that in a vertical pipe filled with a gas lighter than air the absolute pressure at the lower end of the pipe is greater than that at the upper end. Will the same relation hold if the pressures shown by syphon gauges are taken, instead of the absolute pressures? Give the reasons for your answer.

6. The atomic weights of various elements are as follows:

Hydrogen,	H	1	Carbon,	C	12
Oxygen,	O	16	Nitrogen,	N	14
Sulphur,	S	32	Iron,	Fe	56
			Calcium,	Ca	40

Give the molecular weights of, and the proportion by weight in which the various elements are contained in, the following substances:

Carbon Monoxide, CO
Ammonia, NH_3
Sulphuric Acid, H_2SO_4
Calcic Hydrate or Slaked Lime, $Ca(OH)_2$
Sulphuretted Hydrogen, H_2S
Sulphate of Ammonia, $(NH_4)_2SO_4$
Ferric Hydrate, or Hydrated Sesquioxide of Iron $Fe_2O_3 . H_2O$

7. Give a description, illustrated with sketches, of some form of Jet Photometer used for determining the candle-power of gas, and give your opinion as to the reliability of the results obtained by the use of such an instrument.

8. What do you consider the smallest size of cast-iron pipe which it is advisable to lay for street mains, and what weight per foot or per length of 12 feet do you consider suitable for this size of pipe?

9. Give a description, illustrated with sketches, of a cross, or four-way branch, for four-inch cast-iron pipe, giving the dimensions to be used when it is provided with bells, and also those to be used for flanged ends, including the number of bolts and diameter of bolt circle.

10. What details of construction have been adopted in the manufacture of flat flame burners in order to ensure that the combustion of the gas shall take place as far as possible under the conditions stated in the answer to Question No. 10 of the Second Series?

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11. How would you test various samples of gas cooking stoves to determine which was most economical of gas and at the same time did the best cooking?

12. What are the objects sought in mixing sand with lime in making lime mortar and with cement in making cement mortar, and what are the qualities required in a sand to fit it for use in making mortar?

(Answers to these questions are due September 1, 1907.)

ANSWERS TO THIRD SERIES OF QUESTIONS—SECTION OF 1910—PRACTICAL CLASS—TRUSTEES GAS EDUCATIONAL FUND.

1. Name the principal gas coal fields of the United States and Canada, and give the general characteristics of the coal from each field.

Ans. The principal gas coal fields of the United States are located in the Appalachian coal field which stretches along the Appalachian mountain range from New York to Alabama, but gas coal is also found in each of the other great coal fields, viz: the Middle in Illinois, Indiana and western Kentucky, the Western in Missouri, Iowa, Nebraska, Kansas, Arkansas and the Indian Territory and the fields in the far West, the limits of which have not yet been clearly defined nor their resources fully developed.

Among the gas coal districts of the Appalachian field the Pittsburg district which lies immediately east and south of Pittsburg on the Allegheny, Monongahela and Youghioghenny Rivers is prominent. The coal from this district is comparatively hard and dense, so that it can be transported without excessive breakage, and yields a good amount of gas of good quality and a clean hard coke. The percentage of sulphur contained in it is small, being usually well under 1%. A fair gas coal is also found in Jefferson and Beaver Counties, Pennsylvania, but this coal is not quite as good as that from the main body of the Pittsburg field.

Another important field is the West Virginia field located in the northern part of West Virginia along the banks of the Monongahela River. The coal in this field is very similar to

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that obtained from the Pittsburg district, but is less able to stand handling without disintegrating and is apt to contain more sulphur, although some samples show very well in this respect.

The Kanawha district, also in West Virginia, extends back for about 30 miles on each side of that portion of the Kanawha River between Kanawha Falls and Charleston. The coal produced here differs only slightly from the coals mentioned above, except in being apt to contain more sulphur than is found even in the coal mined in the West Virginia district, the percentage running up as high as 1.5% in some samples, although as low as 0.6% in others. Cannel coal is also found in paying quantities in this district.

Kentucky possesses a little gas coal, but hardly enough to be taken into consideration if it were not for its large deposits of rich cannel coals. The best known of these is the Breckenridge, which besides giving off a large amount of rich volatile matter yields also a fairly good coke which can be mixed to a proportion of 10% with the coke from ordinary gas coal without depreciating the latter.

In Tennessee good gas coal is found in Scott and Anderson Counties, while in Campbell County an excellent cannel coal is mined which is similar to the Breckenridge and is known as Jellico cannel. The gas coal is a clean hard coal fully equal in all respects to that obtained from the Pittsburg district.

In Alabama there are three coal fields, the Cahaba, the Coosa and the Warrior, in each of which some coal is found which can be used as gas coal, but the best coal for this purpose comes from the Corona seam in Walker County. This coal is clean and hard enough to bear handling well.

Although Ohio, Indiana and Illinois produce coal that is used locally for gas making, they cannot be considered as gas coal districts, since the coal is only used for this purpose when the gas works are practically over the mines, and Pennsylvania coal is in demand throughout these States for use in preference to the local coal.

In Kansas the Cherokee field produces a gas coal that is good in every respect except that of the amount of sulphur

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contained in it, and this runs from 2.5% to 5% and even as high as 8% in some samples.

The Choctaw country in Indian Territory yields a coal which is clean and hard, stands handling and produces a good coke. It closely resembles the Pennsylvania coals although it contains more sulphur and ash than the latter, the percentage of sulphur being a little over 1%.

The Trinidad field in Colorado also furnishes a clean bright coal that is low in sulphur and is said to give a good yield of good quality gas and from 60% to 70% of compact coke.

On the Pacific coast the South Prairie and Roslyn mines give a coal from which a fair amount of fairly good quality gas can be obtained and which is low in sulphur, but produces a soft, friable and comparatively poor coke.

The principal gas coal fields in Canada lie on Glace Bay and Cow Bay in Cape Breton. These provincial coals were formerly used quite extensively by gas works situated on the Atlantic coast of the United States. They yield a good amount of gas of a quality better than average, but they disintegrate easily, contain a fairly large amount of sulphur and are very susceptible to spontaneous combustion. At the present time their use has been practically abandoned in the gas works of the United States.

Average analyses of some of the coals mentioned above follow:

	Volatile Matter. Percentage.	Fixed Carbon. Percentage.	Ash. Percentage.	Sulphur. Percentage
Pittsburg,	35 to 40	54 to 58	3 to 5	0.6
West Virginia,	35 to 40	53 to 57	4 to 7	1.0
Kanawha,	34 to 40	55 to 62	2 to 4	0.6 to 1.5
Breckenridge Cannel,	47	42	10	0.6
Tennessee Gas Coal,	36 to 39	56 to 60	1.8 to 3	0.8
Jellico Cannel,	50	35	14	0 7
Alabama—CoronaSeam,	34 to 41	50 to 59	7 to 9	0.7
Kansas—Cherokee,	37	52	9	2.5 to 8
Indian Territory,	37 to 40	51 to 55	4 to 7	0.9 to 1.3
Washington—Roslyn,	28	61	9	0.1
Colorado—Trinidad,	33 to 37	51 to 57	9	0.7 to 1.4
Cape Breton,	35	53	5.5	3

(Trustees.)

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2. Give a description, illustrated with sketches, of a retort mouthpiece, showing the manner in which it is fastened to the front of the retort and the arrangement for making a gas-tight joint between the mouthpiece and the lid.

Ans. Retort mouthpieces are invariably made of cast iron, and such a mouthpiece may be described as being a tube of suitable cross section provided at one end with a flange of the size and shape of the front end of the retort and at the other with a faced lip, the cross section of the mouthpiece at this face being either round or more generally elliptical, no matter what the shape of the retort. The lugs required for supporting the lid and its fastening are cast on the sides of the mouthpiece, projecting beyond its faced edge, and an opening to allow the gas to escape from the mouthpiece is made at the proper place in the side, at which place is also provided a bell to receive the lower end of the standpipe. The distance from face to face of flange and lip varies from 14 in. to 16 in., the shape and dimensions of the flange and the opening at the back should be the same as those of the retort, and the width and height of the front opening should also be the same as the corresponding dimensions of the retort, although the shape is, as stated, usually elliptical even with D-shaped retorts.

The mouthpiece is generally fastened to the retort by means of $\frac{7}{8}$-in. bolts about 9 in. long, inserted in holes parallel to the axis of the retort made in that portion of the retort wall at the front end, which is thickened for the purpose. Each of these holes opens at its inner end into a square recess extending in from the outside of the retort. A square nut is put in this recess and the bolt, which is threaded at each end, is inserted in the hole and screwed into the nut. The spaces left in the holes around the bolts are then filled with iron cement, made of one part by volume of fine iron borings or filings and two parts of fire clay moistened with a solution of sal ammoniac, the front of the retort is plastered with a layer of the same cement and the mouthpiece is put on and drawn up tight by screwing down the nuts put on the bolts. The faces of both retort and mouthpiece should be wet before the joint is made. A great objec-

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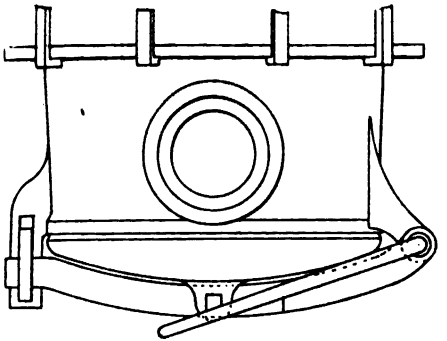
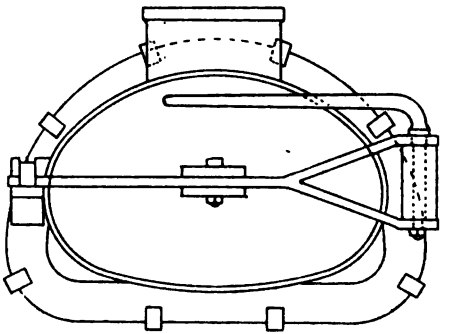


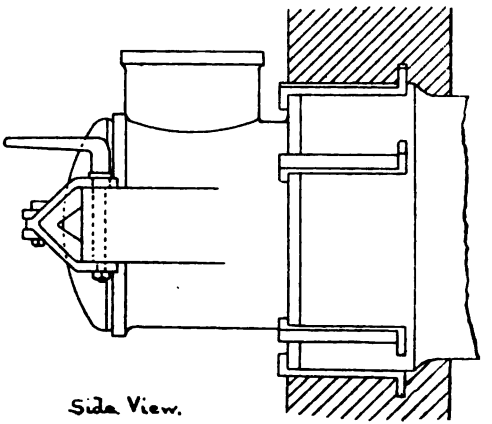
Top View.

Mouthpiece with Self-sealing Lid;

provided with Eccentric Lever Fastening and clamped to Retort.



Front View.



Side View.

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tion to this method of fastening mouthpieces to retorts is that as the bolts burn out after the retorts have been in use for some time, the mouthpieces become loose and it is impossible to keep the joints between them and the retorts tight. It is also impossible to replace a broken mouthpiece by another in case of necessity. To avoid these faults clamps built into the front wall of the bench are often used either in conjunction with the bolts or to replace them. Some of these clamps are provided with set screws which screw down on the front of the mouthpiece flange, while others are merely bent over against this front. In any case, it is advisable to have the mouthpiece flanges set into the front wall of the bench, the faces of flanges and brick work being flush with each other. When this is done the brick work affords a good support to the mouthpieces apart from the fastenings and no injury is done the flanges.

The joint between mouthpiece and lid was formerly made by means of a clay luting, but in recent practice by facing the front of the mouthpiece as described above and making the lid with a V-shaped edge, which is also faced, the lids are made self-sealing. The lid is pressed against the face of the mouthpiece either by a cotter bar and screw or by a cotter bar with an eccentric lever handle. The latter form is the one most frequently used. When it is employed the lid is provided with two lugs cast on it with their vertical centre lines coinciding with that of the lid and one above and one below the horizontal centre line of the lid with sufficient space between them to take the cotter bar to which it (the lid) is fastened by a pin passing through both lugs and the bar. On one side of this fastening the cotter bar branches into two parts with flat circular ends which fit on either side of a lug cast on the mouthpiece. Through this lug and the two parts of the cotter bar passes a pin by which the lid is fastened to the mouthpiece. This pin is turned and the openings in the cotter bar and lug are bored to make the pin a snug fit. The portions of the pin passing through the two parts of the cotter bar are turned to a common centre, but that passing through the lug is turned eccentric to the others. A lever handle is welded to the pin, and by this handle the pin can be revolved in the

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lug and cotter bar. The other end of the cotter bar is single and is caught and held, when the lid is shut, by a hook fastened to a lug on the opposite side of the mouthpiece from the hinge lug. This end being held fast, the eccentricity of the different portions of the hinge pin causes the cotter bar to be thrown toward the face of the mouthpiece, when the pin is turned in the proper direction, and thus presses the lid against the mouthpiece with sufficient force to make the joint gas-tight. The centre pin which passes through the lugs on the lid and through the cotter bar is also made eccentric and thus furnishes an adjustment by which the pressure produced by the action of the main eccentric can be regulated. (Trustees.)

3. Describe the operation of a carburetted water gas apparatus of the generator-superheater type during its regular working, including in the description an account of how to handle the various blast valves so as to bring the different parts of the apparatus to the proper temperatures simultaneously and without any waste of fuel.

Ans. In the normal operation of a carburetted water gas apparatus the work is usually arranged so that the fire is cleaned early in the working day, and the description of the method of operation will be begun with this cleaning.

After the last run is taken off the apparatus should be blown through with only the generator blast valve open, for, say, 20 seconds, to free the space below the fire from any water gas, the blast valve should be closed, leaving the stack valve open, the blower shut down, unless two sets are being worked in conjunction, an examination made to see that all steam is turned off from the set, and then the ash pit and stoke hole doors should be opened and the plugs removed. Working through the stoke holes with the proper tools (hooks and hoes) all the ashes and soft clinker should be loosened up and removed from around the outside of the fire, leaving the centre undisturbed until the work around the sides has been completed. After cleaning out all the clinker that is sufficiently loose and soft to be worked out with the hooks, as much of the

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hard clinker as possible should be cut away from the walls with chisel bars with a slight bend to enable them to reach the proper points, the lumps cut off being removed from the grate with the hooks. It may be necessary to use a sledge on the bars to loosen the clinker if it is very hard, care being taken not to knock down the fire. When all that can be done around the outside has been done without dropping the fire the ashes and clinker should be cleaned out from the centre and the fire dropped on the grate in a solid mass, no large spaces being left unfilled. The centre of the fire is left until the last because, as a rule, the clinker here is softest and the fire is apt to drop and interfere with the work as soon as this portion is disturbed, while it will hold up much better on the sides, and even if it should happen to come down there before the centre is cleaned, the soft clinker can be broken up with chisel bars and all the ashes raked out by working between the grate bars with a long hook. The bottom cleaning having been completed and the ashes removed from the ash pit, the ash pit and stoke hole doors should be closed tight, the charging door opened and the fire barred down from the top to cut off from the side of the generator any clinker situated too high up to be reached from the bottom with the bent bars. This barring down is done with long chisel bars of different sizes, varying from light ones, which can be handled by one man, for use when the clinker is soft, to heavy ones for hard clinker which require three or four men to work them. If the clinker is very hard it may be necessary to drive the bars with sledges until the holes so made have weakened the clinker sufficiently to allow of its being broken down by the hand bars. In all work with bars care must be taken to keep the bars away from the brick work two or three inches of clinker being left on the face of the bricks as a protection against wear and tear. The length of time required for cleaning will vary according to the condition of the fire, but will not usually be more than an hour.

The cleaning having been finished the generator should be filled with fuel and the full blast turned on. It will probably be necessary to make several blows and runs before the fire becomes heated through and during these blows the generator

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blast valve must be kept full open. But when the fire is in good shape the valves on the different parts of the apparatus should be so adjusted as to bring all to the proper temperature simultaneously and without any waste of fuel. The adjustment required for the accomplishment of this object will vary with the condition of the fire and the character of the generator fuel and carburetting material used, and the conditions must be studied for each case. The goal to be worked for is the bringing of the generator up to heat without making any more producer gas than is required to raise the checker work in the carburetter and superheater to the proper temperature for the gasification of the oil. The smaller the amount of combustible gas formed in the generator during the blow the smaller will be the amount of fuel used per 1,000 cu. ft. of gas made, and, therefore, no greater quantity of such gas should be produced than is needed for the heating of the carburetter and superheater. In one case it may be found that the most economical fuel results are obtained when the generator blast valve is not fully opened, in others it may be necessary to have it opened wide. Experiments must be tried with each set of apparatus to determine just how the valves shall be handled so as to avoid, as far as possible, the escape of unconsumed CO, as shown by the presence of a blue flame at the superheater stack, and have all parts of the apparatus heated up within the usual time allowed for a blow, say 6 to 7 minutes. When the apparatus is properly heated the same adjustment of valves will give the desired result for each blow as long the amount of carburetting material used per 1,000 cu. ft. and the amount of gas made per run are not varied to any great extent.

As the operation of putting on and taking off a run was described in the answer to Question No. 3 of the Second Series, it is not necessary to repeat it here. After every four or five runs fresh fuel should be put in the generator to keep the height of the fire as nearly uniform as possible. (Trustees.)

4. Two samples of illuminating gas have the respective compositions given below. Calculate the weight per 1,000 cubic feet and the specific gravity of each sample.

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	Sample No. 1.	Sample No. 2.
Carbon Dioxide, CO_2	1.8%	2.2%
Oxygen, O_2	0.4	0.8
Ethylene, C_2H_4	3.8	13.7
Carbon Monoxide, CO	7.5	29.9
Hydrogen, H_2	49.0	33.5
Marsh Gas, CH_4	33.5	13.4
Ethane, C_2H_6	0.9	2.9
Nitrogen, N_2	3.1	3.6
	100.0	100.0

Ans. In 1,000 cubic feet of gas having the composition of Sample No. 1, there will be:

18 cubic feet of CO_2
4 " " " O_2
38 " " " C_2H_4
75 " " " CO
490 " " " H_2
335 " " " CH_4
9 " " " C_2H_6
31 " " " N_2

The respective weights per cubic foot being:

CO_2	0.11634 lb.
O_2	0.08462 "
C_2H_4	0.07404 "
CO	0.07404 "
H_2	0.00529 "
CH_4	0.04231 "
C_2H_6	0.07933 "
N_2	0.07404 "

the weights in 1,000 cubic feet are:

CO_2	$18 \times 0.11634 =$	2.10 lb.
O_2	$4 \times 0.08462 =$	.34 "
C_2H_4	$38 \times 0.07404 =$	2.81 "
CO	$75 \times 0.07404 =$	5.55 "
H_2	$490 \times 0.00529 =$	2.59 "
CH_4	$335 \times 0.04231 =$	14.17 "
C_2H_6	$9 \times 0.07933 =$	.71 "
N_2	$31 \times 0.07404 =$	2.30 "

and the total weight of 1000 cu. ft. of gas is 30.57 lb.

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The weight of 1,000 cu. ft. of air is 76.357 lb. and therefore the specific gravity of the gas is $\frac{30.57}{76.357} = 0.400$.

By the same method of calculation it is found that the weight of 1,000 cubic feet of the gas having the composition of Sample No. 2 is 47.93 lb. and its specific gravity is 0.628. (Trustees.)

5. The answer to question No. 5, Second Series, shows that in a vertical pipe filled with a gas lighter than air the absolute pressure at the lower end of the pipe is greater than that at the upper end. Will the same relation hold if the pressures shown by syphon gauges are taken, instead of the absolute pressures? Give the reasons for your answer.

Ans. The gauge pressures at the two ends of a vertical or inclined pipe filled with a gas lighter than air do not bear the same relation to each other as do the absolute pressures, the gauge pressure at the top being higher than that at the bottom instead of lower. This difference in gauge pressure between the top and the bottom of an inclined pipe is due to the facts that the syphon gauge does not show the actual pressures, but only the difference between the actual pressures exerted on each leg of the gauge, and that the actual pressure of both the outside air and of gas at rest in a pipe decreases in proportion to their weight as the distance of the point of observation from the centre of the earth increases. The actual pressure of both air and gas at the top of the pipe will be less than at the bottom by an amount equal to the weight of a column of air or gas of unit area and of a height equal to the difference in elevation between the two ends of the pipe. As the gas is lighter than air, the weight of the column of gas will be less than that of the column of air. Therefore, the actual pressure of the gas will decrease less than the actual pressure of the air, and consequently the difference between the actual pressure of the gas and that of the air will increase with an increase in elevation. The lighter the gas, that is, the lower its specific gravity, the smaller will be the decrease in its absolute pressure and the

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greater the increase in the gauge pressure for any given increase in elevation.

The amount of this increase can be obtained for any particular case by dividing the difference between the weight of a column of air with an area of one square inch and a height equal to the difference in elevation between the two ends of the pipe and that of a column of gas of the same area and height by the weight of a cubic inch of water. For a gas with a specific gravity of 0.700 and for a difference of elevation of 100 ft. between the two ends of the pipe, the calculation would be as follows:

The common height of the columns of air and gas will be 100 ft. or 1,200 in., and as the area of each column is one square inch, the volume will be 1,200 cubic inches. A cubic foot of air weighs 0.076357 lb., and a cubic inch weighs $\frac{0.076357}{1728} = 0.00004418$ lb. 1,200 cubic inches of air, then, weigh $0.00004418 \times 1{,}200 = 0.053016$ lb. Since the specific gravity of the gas is 0.700, the column of gas will weigh $^{7}/_{10}$ as much as the column of air, and the difference between the weight of the column of air and that of the column of gas will be equal to $^{3}/_{10}$ the weight of the column of air, or to $0.053016 \text{ lb.} \times 0.3 = 0.0159048$ lb. The weight of a cubic inch of water is 0.036 lb. and the increase in pressure will therefore be $\frac{0.0159048}{0.036} = 0.44$ in. Thus a gas with a specific gravity of 0.700 will show an increase in pressure of 0.044 in. for each 10 ft. increase in elevation, or an increase of $^{1}/_{10}$ in. for each 22.7 ft. of rise.

In the same way we find that a gas with a specific gravity of 0.600 will show an increase in pressure of 0.059 in. for each 10 ft. of rise, or an increase of $^{1}/_{10}$ in. pressure for each 16.9 ft. of rise; gas with a specific gravity of 0.500 will show an increase of 0.074 in. for each 10 ft. of rise, or an increase of $^{1}/_{10}$ in. for each 13.5 ft. of rise; gas with a specific gravity of 0.400 will show an increase of 0.088 in. for each 10 ft. of rise, or $^{1}/_{10}$ in. for each 11.4 ft. of rise, and gas with a specific gravity

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of 0.300 will show an increase of 0.103 in. for each 10 ft. of rise, or an increase of $^1/_{10}$ in. for each 9.7 ft. of rise. (Trustees.)

6. The atomic weights of various elements are in round numbers as follows:

Hydrogen, H	1	Carbon, C	12
Oxygen, O	16	Nitrogen, N	14
Sulphur, S	32	Iron, Fe	56
	Calcium, Ca 40		

Give the molecular weights of, and the proportion by weight in which the various elements are contained in, the following substances:

Carbon Monoxide, CO	**Sulphuretted Hydrogen, H_2S**
Ammonia, NH_3	**Sulphate of Ammonia, $(NH_4)_2SO_4$**
Sulphuric Acid, H_2SO_4	**Ferric Hydrate, or Hydrated Sesquioxide of Iron $Fe_2O_3 . H_2O$**
Calcic Hydrate or Slaked Lime, $Ca(OH)_2$	

Ans. Each molecule of Carbon Monoxide, CO, contains one atom of Carbon, C, and one of Oxygen, O, and its weight is equal to the sum of the weights of these two atoms. Therefore its molecular weight is equal to the sum of the atomic weights of Carbon, C, and Oxygen, O, or to 16 + 12 = 28. This shows that 16 lb. of Oxygen, O, unite with 12 lb. of Carbon, C, to form 28 lb. of Carbon Monoxide, CO, or putting it in another way, that Carbon Monoxide, CO, contains $\frac{16}{28}$ or 57.14 per cent. by weight of Oxygen, O, and $\frac{12}{28}$ or 42.86 per cent. by weight of Carbon, C.

Working in the same way the various substances named are found to possess the following molecular weight and composition by weight:

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Substance.	Molecular Weight.	Parts by Weight in which the Elements enter into the Compound.	Percentage Composition by Weight.
NH_3	$14 + 3 = 17$	14 of N and 3 of H	82.35% N, 17.65% H
H_2SO_4	$2 + 32 + 64 = 98$	2 of H, 32 of S and 64 of O	2.04% H, 32 65% S, 65.31% O
$Ca(OH)_2$	$40 + 2(16 + 1) = 74$	40 of Ca, 32 of O and 2 of H	54.06% Ca, 43 24% O, 2 70% H
H_2S	$2 + 32 = 34$	2 of H and 32 of S	5.88% H, 94.12% S
$(NH_4)_2SO_4$	$2(14 + 4) + 32 + 64 = 132$	28 of N, 8 of H, 32 of S and 64 of O	21.21% N, 6.06% H, 24 24% S, 48.48% O
$Fe_2O_3.H_2O$	$112 + 48 + 2 + 16 = 178$	112 of Fe, 64 of O and 2 of H	62.92% Fe, 35.96% O, 1.12% H.

(Trustees.)

7. Give a description, illustrated with sketches, of some form of Jet Photometer used for determining the candle power of gas, and give your opinion as to the reliability of the results obtained by the use of such an instrument.

Ans. The Improved Lowe Jet Photometer is an example of the type of these photometers, which determines the candle power of gas from the pressure required to maintain at a fixed height a flame produced by burning the gas through an orifice of a definite size. It consists essentially of a King's pressure gauge on top of which is fixed a small steatite tip, with a fine circular orifice, through which the gas is burned as it issues from the gas space of the gauge. The gauge is mounted in a wooden case with a glass door. On the back of the case a horizontal line is marked at a height of 7 in. above the top of the tip, and a piece of colored glass on the door has its top edge at the same height. A dry governor is placed in front of the stop cock on the gas pipe leading to the gauge, so that the pressure on the supply side of the stop cock is kept constant. The stop cock has a long lever handle the free end of which moves over a scale marked on a quadrant attached to the side of the case, as shown on the cut. The gauge is made so as to give the least possible friction, and this in connection with the

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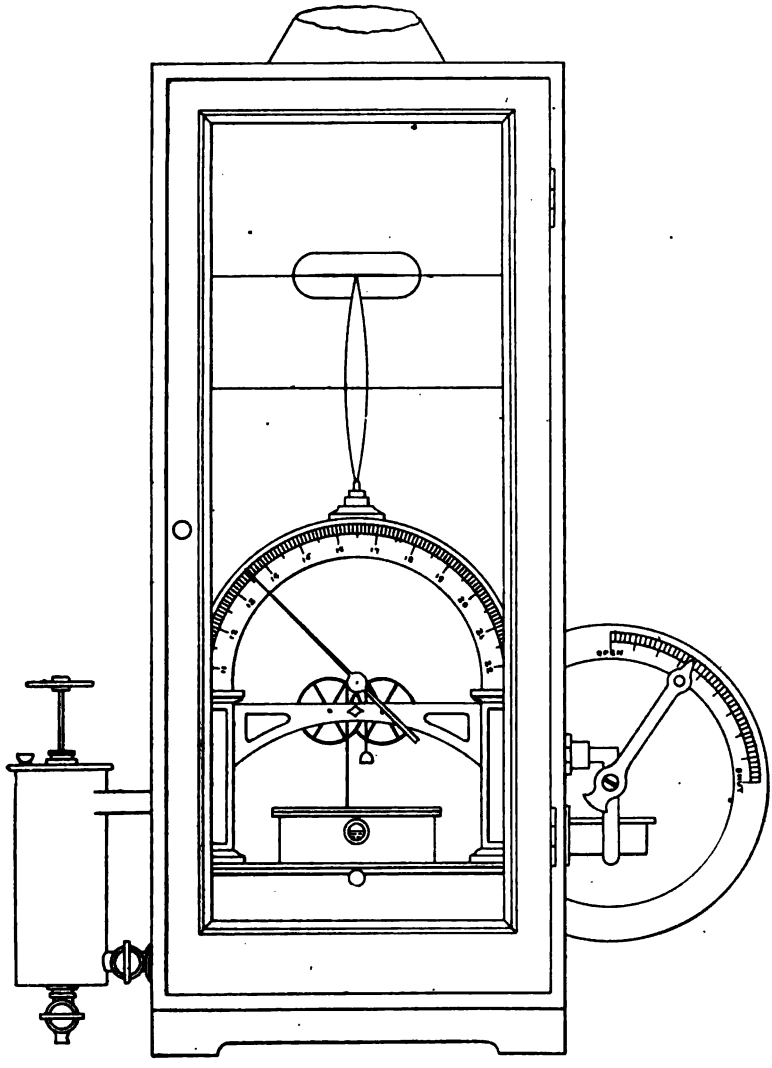

Lowe Jet Photometer.

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close adjustment of the supply of gas, made possible by the long handle of the stop cock, enables the height of the flame to be regulated so that its tip is exactly in line with the marks on the door and the back of the case as determined by sighting from one line to the other.

In the old form of these photometers the scale on the gauge is graduated to hundredths of an inch and the candle-power, corresponding to the pressure which exists when the flame is adjusted to the proper height, is obtained from a table furnished with the instrument, either separately or in the form of an auxiliary scale placed below the pressure scale and properly tied into it. In the more modern forms there is no pressure scale as such, the semi-circular scale over which the pointer of the gauge travels being graduated to give the candle-power by direct reading, as shown on the accompanying cut.

It is of course important that the gauge should show the correct pressure, and to do this the water line must be maintained at the proper level at all times. The adjustment of the water line is provided for by a small cylindrical tank mounted on the side of the case opposite to that on which the gas cock is placed. This tank, which communicates with the gauge by a connecting pipe, is provided with a piston, and the space below this piston being filled with water, the water line of the gauge can be readily adjusted to the proper level by moving the piston up and down according as the water is above or below the proper point.

Another style of jet photometer, of which the Jones Jet is an example, determines the candle-power of the gas, from the varying height of a flame produced by burning the gas through a small orifice at a constant rate or at a constant pressure. The Jones Jet consists of a steatite tip with a fine circular orifice to which the gas is supplied by a volumetric governor and the candle-power scale is marked on a colored glass chimney surrounding the flame.

If illuminating gas could be made at all times of a uniform composition, a jet photometer if once correctly adjusted would give fairly accurate absolute candle-power results. Since it is not possible to make such gas of a perfectly uniform composition

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such a photometer cannot be depended upon to give absolute results that are accurate, as even when the tip is of the proper size for the kind of gas to be tested and the readings are correct when the gas has a certain composition, any change in this composition will change the readings even though the illuminating value remains the same. It is obviously entirely out of the question to attempt, as is sometimes done, to use the same jet photometer without change of tip for both coal gas and carburetted water gas, or a mixture of coal gas and carburetted water gas.

The true field of the jet photometer is to furnish a rapid method of obtaining frequent tests of candle-power that can be compared with one another and thus afford a check upon manufacturing results that cannot be obtained by comparatively infrequent tests made upon a bar photometer. But even when used in this way the reading of a jet photometer should be compared every day or two with the candle-power as shown by a bar photometer in order to be certain that through change in composition of the gas or in the size of the orifice in the tip, these readings do not vary too much from the actual candle-power of the gas. (Trustees.)

8. What do you consider the smallest size of cast-iron pipe which it is advisable to lay for street mains, and what weight per foot or per length of 12 feet do you consider suitable for this size of pipe?

Ans. It is not good practice to lay any cast-iron pipe of a smaller diameter than 4 in., except in localities where it is reasonably certain that a smaller pipe will be able to deliver for an indefinite period, without undue loss of pressure, all the gas required in the territory to be supplied.

A good average weight for 4 in. cast-iron pipe is 232 lb. per length of 12 feet, or about 19.3 lb. per foot. For use in very small towns lighter pipe can be employed, while in some locations in large cities heavier pipe is needed, but for general use the above is, as stated, good average weight. (Trustees.)

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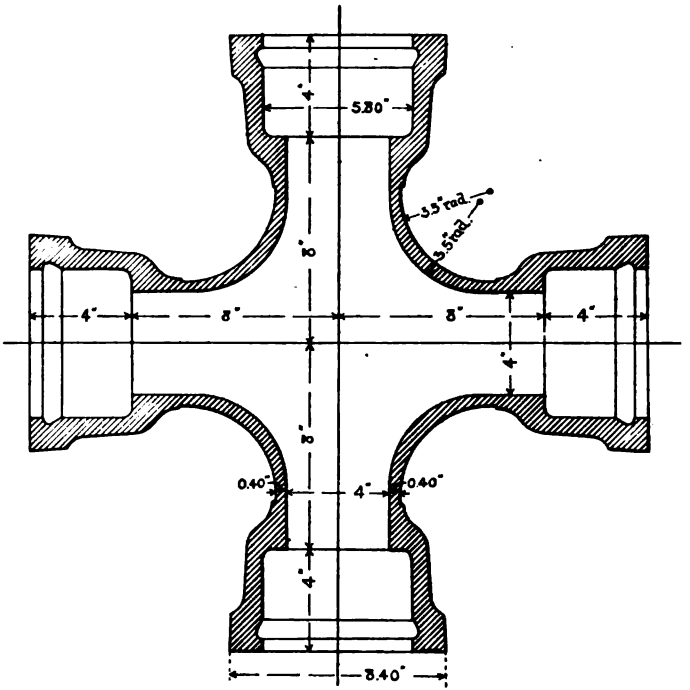
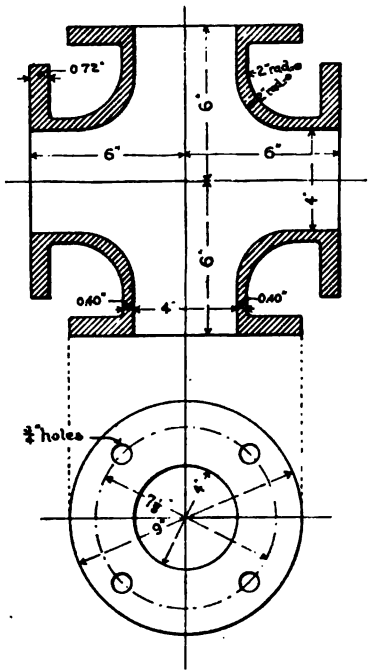


Four-inch Cross with four Standard four-inch Bells.



Four-inch Flanged Cross.

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9. Give a description, illustrated with sketches, of a cross, or four-way branch, for four-inch cast-iron pipe, giving the dimensions to be used when it is provided with bells, and also those to be used for flanged ends, including the number of bolts and diameter of bolt circle.

Ans. A 4-in. cross or four-way branch made according to the American Gas Light Association standard is shown on the accompanying cut. The bell cross has a bell on each outlet unless otherwise specified, although any desired combination of bells and spigot ends can be made. The distance from the centre line of each run to the bottom of the bells on the other run is 8 in. The depth of the bells is 4 in. and the other dimensions are as shown on the cut.

For a flanged cross the distance from the centre line of the runs to the faces of the flanges is 6 in. in each case. The outside diameter of the flanges is 9 in., the diameter of the bolt circle is 7⅛ in. and the flanges are drilled with four ¾ in. holes placed as shown.

It is at present under discussion, whether it would not be better to make the dimensions from centre of cross to bottom of bell and from centre of cross to face of flange the same for crosses of the same size, so that both kinds will take up the same amount of space in a line of pipe. (Trustees.)

10. What details of construction have been adopted in the manufacture of flat-flame burners in order to ensure that the combustion of the gas shall take place as far as possible under the conditions stated in the answer to question No. 10 of the Second Series?

Ans. The following details of construction have been adopted to put into effect the principles brought out in the answer to question No. 10 of the Second Series. To insure the existence of a low pressure at the burner tip the improved forms of flat-flame burners are provided either with some form of governor, which maintains the pressure of the tip constantly at the proper point, no matter how much the pressure on the piping increases, or else with a "check," which is usually a metal, steatite or lava disk inserted in the burner pillar so as

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to cut off any flow of gas to the tip except through a hole in the disk, the area of which is smaller than that of the opening in the tip, the relation between the area of the opening in the check and that of the opening in the tip varying with the pressure at which the burner is designed to be used; that is, the higher the pressure the smaller the hole in the check for the same sized tip.

In order to maintain the temperature of the flame at as high a point as possible the burner tip should be made of a non-conducting substance, since if made of metal or any other good conductor of heat, the heat which is absorbed and carried away by the tip reduces the temperature of the flame. In all of the best forms of flat-flame burners the tips are now made of either lava, steatite or enamel, all of which are poor conductors of heat.

To produce a steady, even flow of gas without any swirling motion some burners have placed between the check and the tip a screen of fine wire gauze which breaks up any currents, and renders the flow of gas uniform throughout the whole area of the burner pillar, while others depend upon the steadying action produced by the large area of the burner pillar above the check as compared with the area of the opening in the tip.

To secure an equal supply of gas to all parts of the flame, slit (batswing) burners are made with what is called a hollow top, by means of which the slit is kept of the same depth in all parts instead of being much thicker at the top than at the sides, as it would necessarily be if the top of the tip were left solid instead of hollowed out inside to conform with its shape outside. The effect of extra thickness at any place is that less gas passes through the slit at the thick place, and that consequently the conditions are not the same at all parts of the flame. A further improvement in this direction, introduced in some burners, consists in cutting the slit with a circular saw applied from above the tip and thus making it curved on the bottom instead of flat, as is the case when it is cut by sawing in the ordinary way. With the flat bottom slit some of the gas issues at right angles to the axis of the burner only to be folded

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back on the upper part of the flame by the upward draft of air caused by the heat of the flame, while with a curved bottom slit this effect is avoided as the gas issues in a direction along which it is free to travel without being turned aside, and the flame is thus kept of more even thickness throughout.

In Sugg's table top burners the effect of the upward rush of air in increasing the thickness of the lower edges of the flame is still further guarded against by forming a circular "table" immediately under the top of the tip, the projection of which deflects the currents of air and prevents them from rising vertically against the flame. (Trustees.)

11. How would you test various samples of gas cooking stoves to determine which was most economical of gas and at the same time did the best cooking?

Ans. The comparative efficiency of the top burners of various samples of gas stoves may be tested by determining the length of time and amount of gas required to heat a definite quantity of water from a temperature of, say, 60 deg. F. to the boiling point. The same kettle should be used throughout the tests and the weight of water employed, its temperature at the start, the exact time at which it begins to boil and the amount of gas consumed must be accurately determined in each case.

The efficiency of the ovens may be tested by determining the time and amount of gas required to bring each oven up to a baking heat and then to bake a definite weight of either bread or biscuit. The dough must be all ready to put into the oven as soon as the required heat is attained so that no gas is wasted while waiting for the dough to be gotten ready, since any delay of this kind would spoil the tests. Each oven should also be tested for evenness of distribution of the heat throughout its whole interior. This can be done by placing pieces of white writing paper in different parts of the oven, and noticing the extent to which the different pieces are browned when the oven is hot enough to bake. The more nearly they all approach to the same color the more uniform is the distribution of heat throughout the oven, and the better will it bake. As a

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rule, the ovens that show a good efficiency by the baking test will also show a uniform distribution of the heat. (Trustees.)

12. What are the objects sought in mixing sand with lime in making lime mortar and with cement in making cement mortar, and what are the qualities required in a sand to fit it for use in making mortar?

Ans. "Sand is mixed with lime or cement to reduce the cost of the mortar; and is added to lime also to prevent the cracking which would occur if lime were used alone. Any material may be used to dilute the mortar, provided it has no effect upon the durability of the cementing material and is not itself liable to decay. Pulverized stone, powdered brick, slag, or coal cinders may be used; but natural sand is by far the most common, although fine crushed stone, or 'stone screenings,' are sometimes employed and are in some respects better than natural sand.

"To be suitable for use in mortar, the sand should be sharp, clean and coarse; and the grains should be composed of durable minerals, and the size of the grains should be such as to give a minimum of voids, *i. e.*, interstices between the grains.

"The usual specifications are simply: 'The sand shall be sharp, clean and coarse.'

"Sharp sand, *i. e.*, sand with angular grains, is preferred to that with round grains, because (1) the angular grains are rougher, and, therefore, the cement will adhere better; and (2) the angular grains offer better resistance to moving one on the other under compression.

"The sharpness of sand can be determined approximately by rubbing a few grains in the hand, or by crushing it near the ear and noting if a grating sound is produced; but an examination through a small lens is better. Sharp sand is often difficult to obtain, and the requirement that 'the sand shall be sharp,' is practically a dead letter in most specifications.

"Clean sand is necessary for the strongest mortar, since an envelope of loam or organic matter about the sand grains will prevent the adherence of the cement. The cleanness of

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sand may be judged by pressing it together in the hand while it is damp; if the sand sticks together when the pressure is removed, it is entirely unfit for mortar purposes. The cleanness may also be tested by rubbing a little of the dry sand in the palm of the hand; if the hand is nearly or quite clean after throwing the sand out, it is probably clean enough for mortar. The cleanness of the sand may be tested quantitatively by agitating a quantity of sand with water in a graduated glass flask; after allowing the mixture to settle, the amount of precipitate and of sand may be read from the graduation. Care should be taken that the precipitate has fully settled, since it will condense considerably after its upper surface is clearly marked.

"Although it is customary to require that only clean sand shall be used in making mortar, a small quantity of very finely powdered clay will not materially decrease the strength of the mortar. In some instances clay to the amount of 10 per cent. of sand seems not to decrease the strength of the mortar. Mortar containing considerable clay is much more dense, plastic and water-tight; and is occasionally convenient for plastering surfaces and stopping leaky joints. Such mortar is not affected by the presence of water.

"Coarse sand is preferable to fine, since (1) the former has less surface to be covered and hence requires less cement; and (2) coarse sand requires less labor to fill the interstices with the cement. The sand should be screened to remove the pebbles, the fineness of the screen depending upon the kind of work in which the mortar is to be used. The coarser the sand the better, even if it may properly be designated fine gravel, provided the diameter of the largest pebble is not too nearly equal to the thickness of the mortar joint.

"If the voids are filled with cement, uniform coarse grains give greater strength than coarse and fine mixed; or, in other words, for rich mortar coarse grains are more important than small voids. But if the voids are not filled, then coarse and fine sand mixed give greater strength than uniform coarse grains; or, in other words, for lean mortar a small proportion of voids is more important than coarse grains.

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"As a rule, the sand ordinarily employed in making cement mortar is much too fine to give maximum strength, or to permit the use of a minimum amount of cement.

"The smaller the proportion of voids, *i. e.*, the interstices between the grains of sand, the less the amount of cement required and consequently the more economical the sand.

"Very fine sand makes a much weaker mortar than coarse sand, and natural sands vary considerably in the proportion of voids and consequently differ in the amount of cement required to produce any particular strength. Therefore, before adopting a sand for a work of any considerable magnitude, all available sands should be carefully examined with reference to (1) their effects upon the strength of the mortar, (2) their per cent. of voids or the amount of cement required with each, and (3) their cost. If mortar of any particular strength is desired, the proportion of cement should be adjusted according to the fineness and voids of the best available sand." (Baker's Masonry Construction.)

THE PRESIDENT: Gentlemen, we have just heard the report of the Trustees of the Gas Educational Fund made to us as one of the subscribers to the fund. The Institute subscribed $350.00 a year, and this is a report to the Institute as if it were an individual subscription. Owing to the relation that the old gas institution held to the fund, the Secretary has come here to read the report and ask us if we have any criticisms or suggestions. The report is now before you.

MR. C. H. NETTLETON: I would move that the report be accepted; published in the Proceedings accompanied by the questions and answers sent out to the various classes during the year.

MR. WM. MCDONALD: Second the motion.

MR. J. D. MCILHENNY: I would like to ask what has been done with the proposed publication of the questions and answers in one volume. It seems to me they have accumulated a vast amount of valuable information there which to-day is prac-

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tically inaccessible. We have to wade through a lot of volumes in order to find it, and if it was condensed in one volume it would be very useful. I understood that that was going to be done.

THE PRESIDENT: That was referred to in the report, and I will ask Mr. Forstall to report further in regard to it.

MR. A. E. FORSTALL: Briefly, we are working on the matter, but the publication of that volume has been delayed partly because of an attempt to learn whether or not there were any authoritative figures for the weights and the calorific values per cubic foot of different gases on which no two text-books agree, and partly because the Secretary has not had time enough to devote to the work to put it through.

THE PRESIDENT: All in favor of Mr. Nettleton's motion that the report be accepted, published in the Proceedings, accompanied by the questions and answers sent out to the various classes during the year, will say "Aye." Contrary minds, "No." Carried.

The next business of this meeting is the hearing of a paper on the "Obligations Imposed by the Possession of a Franchise," by Mr. Charles H. Dickey.

OBLIGATIONS IMPOSED BY THE POSSESSION OF A FRANCHISE.

BY CHARLES H. DICKEY, of Baltimore, Md.

Mr. President, and Gentlemen of the American Gas Institute:

I beg to acknowledge both the pleasure and honor of being permitted to speak to you on this occasion. It is a pleasure, because I am among my friends and see around me the intelligent and earnest workers of our Gas Institute, and I consider it an honor because I feel deeply the subject under discussion. I feel that I am discharging a high responsibility to you and our interests, which are necessarily of a public and corporate character, and if in my remarks I have assisted you

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in these great undertakings I shall consider my work well done. I fully realize that an occasion of this sort is fraught with great possibilities. There are influences that can be made impressive and far reaching. At this time, therefore, it is well for us to pause and bestow a serious thought upon matters of interest and moment to us all.

There is a school of philosophy which holds that all good deeds and all ethical impulses are ultimately rooted in selfishness. There is another school which maintains that the greatest good to the greatest number is the motive and end of moral effort. There is still another school of ethical thought which contends that the inner conscience is the sole director and arbiter of right action—that right for its own sake is the final and ruling motive.

In presenting to you what I consider the obligations imposed by the possession of a franchise I think I have blended the theories of each of the three schools just referred to. I urge these obligations because I believe it is to the interests of those upon whom they rest to faithfully discharge them; secondly, because their performance carries with it the widest public utility and advantage; and, thirdly and chiefly, because wherever an obligation arises it is right to properly fulfil it.

Before defining and classifying the various duties of which it is my privilege to speak to you, I beg to make a few preliminary observations of a general character.

A franchise, as under discussion here, as we well know, is the power of a corporation to exercise various rights and privileges. These rights are the creatures of law and exist solely by sovereign grant. They spring from the people, from that power which resides only in the people, and it is important for us to fully appreciate that all franchises are necessarily bestowed by popular will. They are privileges which the people have delegated to their fellow-men to do for them what they cannot reasonably do for themselves. These are facts, fundamental and underlying, and should be borne in mind throughout the whole consideration of the subject in question. Each franchise, therefore, carries with it an obligation *to* the Commonwealth or community which bestows it, and each franchise

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also carries with it an obligation *from* the Commonwealth or community which bestows it.

There is another fundamental principle connected with these grants which makes it necessary that the corporation act within the scope of its powers. It must not wrongfully or unlawfully assume to take that which does not rightfully belong to it. If the State has granted a franchise which we will designate as "*a*," we have no right to claim "*b*," "*c*," and "*d*" in addition to "*a*." Therefore, it becomes necessary, in defining this scheme to state that the by-laws of our corporations and its proceedings shall not be inconsistent with its charter, nor with the general laws of the land. Equality is equity, and equity in dealing with the public is a supreme and vital obligation, and our corporations must remember this potent fact and carry out its work impartially to all. All those things which may be done within the letter of the corporate charter must not be done in an oppressive and intolerable way, but we must remember that there is attached to every franchise an implied but distinct duty to use it reasonably.

With the just and full enjoyment of all our rights and powers which have been granted, there is surely a right to the State to the reasonable control of their exercise but never taking from the substance of the privileges bestowed. Many questions have arisen in the past, and many questions will arise in the future of an important and delicate nature, because a corporation is an institution of the State, having been granted for its own convenience in performing public functions, and, therefore, its charter may be amended or appealed, and it is in this aspect as we look at the subject calmly and deliberately that the State and the incorporators are deemed to occupy the position of contracting parties, the franchise flowing from the State being its consideration and the obligation to perform the corporate functions being the obligation imposed upon the corporation.

Another point which must be kept plainly in view in considering these matters is that vague and ultimate power resident in every State, the power which, for the want of a better name, we will call the "police power," which means that all

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property is necessarily subject to this power. It is the supreme power or right of the State to protect and preserve itself and its subjects. It deals with public health and public safety, public morals and public welfare. Accordingly, all corporate franchises are held subject to this sovereign power. Our corporations are required to do or not to do many things by virtue of this power, but in defining this power I would say that the regulations must have reference to the comfort, safety and welfare of society, yet they must not be in conflict with any provision of the charter. They must not, under pretense of regulation, take from the corporation any of its essential rights or privileges which the charter confers. In short, it must be a regulation *in fact,* and not amendments of the charter in curtailment of the corporate franchises.

It has been claimed that the power of interference and control by the States would be inconsistent with the property rights of the corporation. I refer to such laws that require corporations to make such rates or charges for the benefit of the Commonwealth, and it seems to be settled by decisions of the courts that the State rights may require such conditions from the corporations to deal impartially and equally with the public to prevent discriminations against different classes for like service. These regulations must be reasonable and not confiscatory or arbitrary. This power has been held to exist to prevent injustice and extortion, also upon the ground that corporations whose business and circumstances are such as to give them a practical monopoly in a special field of production or service which concerns the general public, are necessarily subject to have their privileges controlled in this way.

In a great case decided in the Supreme Court of the United States, that august tribunal said: "Generalized and divested of the special form which it assumes under a monarchical Government based on feudal traditions, a franchise is a right, privilege or power of *public concern* which ought not to be exercised by private individuals at their mere will and pleasure, but should be reserved for public control and determination either by the Government directly or by public agents acting

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under such conditions and regulations as the Government may impose *in the public interest and for the public security.*"[1]

And so in a large number of cases, franchises have been defined as a privilege of a *distinctively public nature* originating in legislative grant.

In one case[2] it was said: "Franchises are rights and privileges acquired only by special grant from the public through a Legislature, *which imposes upon the grantee, as a condition therefor, a duty to the public to see that they are properly used.*"

The deep importance of this conception cannot be too seriously appreciated.

The principle of corporate life is intricate. It is extensively wrought into the constitution and working of modern society, and it is not too much to say that without such institutions the present high development of society, and particularly of its industrial phases, could not be maintained at all.

The whole matter of transportation has passed into the control of corporations; so have all the applications of light, steam and electricity. The wondrous work wrought by the locomotive, the telephone and the telegraph, the gas engine and the electric motor, are all agencies which invention has developed. The invention of man developing these conveniences for mankind must naturally be in the hands of the corporations, and it is easy to see that their relations to society are most intimate. They are extensive and their stupendous powers are exercised directly upon the resources of every person in every community. They have brought about new conditions, and these conditions are not temporary, and in the development of society it must permanently adjust itself to them. We can but stop and think, almost bewildered, of the great and extraordinary powers of these corporations created by the law, and their relations which they have to the Commonwealth which has created them, and there comes at times a feeling of extreme uneasiness which pervades the community concerning

[1] California vs. Central Pacific R. R. Co., 127 U. S. 40.

[2] St Louis, etc., R. R. Co. vs. Balsley, 18 Ill., App. 82.

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their action. It is believed by many that their great and important prerogatives are not at all times used fairly in relation to public interests which are affected by their exercise.

Let me state the case in this respect as ably and strongly presented by an impartial authority upon the subject, in order that we who are assembled here may the more deeply and vividly realize the delicate and important nature of the obligations due from us to the public in the administration of the responsible interests with which we are identified, and in order that, imbued with that realization we may double ourselves in energy, strength and devotion to render a wise and conscientious account of our great stewardship:

"Apprehension is founded not in the idea that corporations acting in the legitimate exercise of their powers, vast as they are, menace in any way the Commonwealth, so much as in the conviction that the control of those powers is inadequately accorded and that they may be and are seized upon by irresponsible persons who abuse them in their personal interests.

"Great fortunes have suddenly accumulated in the hands of individuals, but not only this, but by those means and by the operation of the principle that a mere majority determines corporate action an almost irresponsible control is obtained over enormous amounts of the money of other people. This facilitates in practical affairs the concentration of the absolute control of a number of railroad corporations all acting directly upon the most vital relations of society, in the hands of a few persons actually owning but a small proportion relatively of their stock. This involves the development of a social power in the hands of mere citizens, unprecedented in society and overshadowing mere political power, for it acts directly, as has been said, on the relation between the resources of every man, even the poorest, and the cost of subsistence of himself and his family. It may be borne in mind that the powers whose burdens in every time past have produced a policy of discontent and led on to revolution have been social and not political ones. That it is possible for any individual to start with nothing and in a few years come to irresponsible administration of such a force for private uses, is evidence that at least the

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sources of so great a social power are at present very insecurely guarded.

"These considerations serve to indicate the social relation of these corporate persons and the tendency of the proper use and of the abuse of their peculiar constitution. Society will be sure to establish for itself such safeguards as justice and sound economy may dictate. The courts have held that corporations are amenable to the control of the State, in their business and property and rates of charge, to at least the same extent as natural persons are, unless they are freed from such control by elements of contract in their charters; and there are those who insist that the State cannot in any way disengage itself from its elements of sovereignty nor part with its legislative or judicial powers.

"It is impossible that any principle of law can exist, under whatever formulæ it may be said to lurk, which requires society to be still while it is financially despoiled or is otherwise menaced in the beneficent working of its organization."

Such, then, is the magnitude of the obligations of which I am now speaking.

Now, gentlemen, I do not wish you or any of our worthy friends who may read these lines or those on which I shall speak later in regard to graft, to think that I hold that all corporations are, as a rule, corrupt, for I know from my own personal observation that this is not and cannot be true; but somehow the average citizen is imbued with erroneous ideas on this subject; he has had no doubt brought home to him many cases of greed and graft, not only in connection with public-service corporations, but chiefly in connection with civic administration of affairs, of which probably the State building at Harrisburg furnishes a conspicuous example, and from these observations he probably considers many of our corporations alike, and has by degrees come to the belief that many of them are affected with the unfortunate evil in question. This is, of course, an utterly extravagant and unwarranted view of the case, and it is for us, by a rigorous and determined insistence upon the strictest standards of propriety, to entirely disabuse

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the mind of even the most skeptical of all prejudice against corporations upon this score.

With these essential conceptions in mind, let us take up more at large the obligations which they suggest as being laid upon the members of the public-service corporations. *The people must be treated justly.* There is no firmer or broader foundation upon which the true interest and steady upbuilding of public-service corporation can rest than the respect, the confidence, the good-will and gratitude of the population it serves. No corporation ever failed on account of, but, on the contrary, many corporations owe their success and advancement to liberal dealing with the public, and a generous realization of and respect for public rights. I am not encouraging a toadying, weak-kneed sacrifice of corporate rights. I am speaking of a wise and just regulation and use of our rights for the common good, so that our own advantage and our own sense of justice and of duty well done may be harmonized with the development, the enrichment and progress of all.

In defining grants from the people to the corporations I have stated that a contract exists, and the fulfillment of same should be an obligation not only upon public corporations, but also upon the Commonwealth under which it is exercised. The people are prone to forget their petitions to these corporations in the early days of their existence, when large tracts of land were granted for shops and other inducements were offered in order to have railroads and other enterprises come to their door. They forget as they grow into large centres that although these franchises were granted by the people, yet, nevertheless, the individual enterprise of progressive and active men complied with their wishes. They brought to them their railroads and built their gas and electric plants, and it is an obligation on the part of the people not to allow their good judgment or just opinions to be clouded so that unwarranted action is taken to obstruct or wrongfully control these very corporations which have helped to make them great and prosperous.

I have also said that the corporation must not delegate unto

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itself powers which are not granted in its franchises, and in accepting the franchise or in the purchase of a property the impressions that are made on the public mind will go far toward your success or failure. The rights of the corporation clearly do not come before the rights of the people. No announcement should be made of curtailment of service in order that dividends must first be paid before the public is best served, because the purchase of any property carries with it the obligations as imposed by the franchise, and by taking the people into its confidence with the understanding that every effort will be made to build up for their benefit, there will be co-operation and support which can be gained in no other manner.

The time seems to have come when it is the natural desire in all these affairs to treat the people with the consideration which is due them. And let me say here, that we occupy a position to-day that has very much to do with the future of our corporations as to what disposition will be made on these questions by the will of the people. We must not live too close to the letter of the law; we must not draw the lines too tight or too fast, without giving due consideration to the situation, but we must make such rules that will treat with the people, showing them a broad and liberal attitude which our corporations mean to maintain.

The making of rules is very important and must of necessity have great bearing upon the ultimate workings of our corporations, but no matter how favorable such rules are, no matter what instructions are given, it is the man behind the desk, the man in his daily labor who is the cushion between the corporation and the public, and it is for him and for all of us to realize the fact, not only that we are working for the corporation and its best interest, but also recognize the fact that there is a duty from us to the people, a courteous manner which will produce respect, and, unless this is faithfully carried out, these rules will fail of their most desired end.

It is, therefore, necessary for the public-service corporation employees to recognize to the fullest extent that they are not only working for the corporation, but also recognize the fact that they are serving the people from whom their corpor-

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ation gets its rights and privileges. It is in this attitude, therefore, that our work should be done so that we may instill into the minds of the people a clear and comprehensive idea of our desires. And it is evident to my mind that such schooling on our part would certainly produce that confidence and trust desired, proving beyond a doubt the fair dealings and liberal policy established by the corporation. It has been clearly demonstrated that one of the first rules in life to one's fellow-man is courtesy and respect. With that he will rise in the ranks with the trust and confidence of all, and with this in mind he will eliminate all the worst elements that affect the workings of public corporations. He will have ambition, but it will be built up on the lines of faithful service and the earnest desire for the fair treatment that must necessarily come to him at the hands of the corporation, because in dealing with their employees the corporation owes to them an obligation of reward for fidelity to their duty; it owes them the adequate provision for health and comfort and protection from every quarter.

Nor should the corporation forget its duty and obligation to its stockholders. Those who manage its corporate affairs are trustees for the stockholders. Every fair, just and lawful effort should be made to serve and promote the interest of those who are the stockholders as the real proprietors of the corporation, and weighted with such responsibilities, which it is unnecessary for me to describe in this presence, every true official should seize upon every fair opportunity to promote the corporate good.

There is another obligation which I would urge, and that is the wisdom of maintaining frank and just relations with the press. The newspaper of to-day is a great educational and moral agency; it molds and sways public opinion, and it makes an impression directly upon the public intellect. It is important, therefore, that we should earn the good-will of this great agency of the public service. This can be done by the pursuit of a fair policy on the part of the corporations with frankness and confidence. It seems to me there is no one more quickly or heartily responsive than the intelligent, public-spirited newspapers of this country. Guided by broad and enlightened in-

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tellects they are seldom led astray. If they are deceived they soon learn to appreciate the attitude, and woe unto the body corporate which so conducts itself as to bring down upon its head the lightning of a respected and powerful editorial Olympus. Before leaving this subject, however, it gives me much pleasure to read a copy of a letter received by one of the members of our Gas Institute from the editor of one of our large daily papers, as follows:

"My Dear Mr.———: I am sorry I missed you when you called. I am sorrier that you are leaving ———, not only on the ground of the very pleasant personal relations which are broken thereby, but on account of the loss sustained by the gas-using public. Under your management the ——— Company was a model public-service corporation in the matter of courtesy and considerate treatment of the public and in the efforts to meet all reasonable demands. You are the only manager of a public-service corporation within my knowledge who handled the business as if it were competitive and succeeded in making the people pay a price which they considered too high—smile. I hope you will have success in your new field.

"Yours sincerely, ————."

I wish to also read from a clipping which I took from one of the large newspapers a short time ago in another of our large and progressive cities, as follows:

"Any man who enters a strange city to assume the management of a public-service corporation has his work cut out for him. It is neither his fault nor that of the public that he is apt to be regarded with some hostility. The public has been fooled into making disadvantageous contracts. It is met with all sorts of management, mostly the high-handed sort, which says: 'There is our franchise and we propose to take full advantage of it.' When Mr. ——— came to ——— to assume management of the gas company the public accepted him on suspicion, but he will leave ——— with the hearty good-will of every citizen who has kept him and his policy in view. Mr. ——— has shown admirable tact in administering the

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affairs of his employers and in maintaining a proper consideration for the company's patrons."

There is another obligation which appeals to me, perhaps, more strongly than any of those touched on; and in this connection I wish to quote a few words taken from the address of one of our learned judiciaries, delivered in Jamestown some few weeks ago, as follows:

"In this hour of angry retaliation upon the corporations, an hour in which the innocent suffer with the guilty, we must not forget that public officers are themselves most to blame. The money was solicited under circumstances ofttimes amounting to a demand. Its acceptance created an obligation. The alliance which arose has cost the people dear. Wisely did Mr. Bryce advice us that 'we should aim to bring as few financial interests as possible within the sphere of governmental activity.'"

It is for the corporation to keep itself clean and above suspicion and graft. It is to my mind the very best thing that the corporations of this country can do in their own interest as well as in the interest of the public whom they are serving, and the citizens of the Commonwealth would do well to lend them a helping hand in striking down and trampling under heel the régime of graft which has spread itself over the country. Every corporation should make the first article of its by-laws imperative that no special favor of any sort or any consideration should under any circumstances whatever be extended to any member or officer of the Government. It would be an inestimable boon and godsend to the whole nation. The corporations would thus not only achieve incalculable public good, but they would loom up like lofty oaks in an evergreen forest of popular respect and affection. The corporations should not intervene in legislation, and if they do not there would be no legislative tax upon them for the purpose of extorting money. Therefore, under any circumstances whatever let us refuse to buy or bribe public officials, or to take part in elections, or to intervene corruptly in legislation, and in setting our face like a flint against these practices the public-service corporation would not only be secure in its own im-

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munity from grievous evils; would not only bestow positive good upon itself, but would be discharging an obligation of the highest character to the people and to the State.

Now, gentlemen, a few words in conclusion and I shall have done.

We live under a régime of law. Ours is a Government of law—rooted in the hearts, upheld by the patriotism, administered by the wisdom of a law-abiding people who have been trained by inveterate instinct and intuition, developed from the rude institutions of the Saxon forests, through every period of transition and progress to the present time, in the ways of civil liberty and self-rule. To the dominion of the law as interpreted and applied by able, impartial and fearless Courts, we turn with a serene and abiding sense of safety. This is the anchor of the ship of State. This is the tabernacle in which the rights, the liberties, and property of the people are sheltered. The citizens of the great Republic, come what may, shall still cling to this principle—the supremacy of the law—as the shipwrecked mariner clings to the last plank when night and tempest close in upon him. But by wise conduct, especially upon the part of all who have a stake in the protection of society, there shall be no night and there shall be no tempest. All that capital and vested interests ask for is *justice*. In the name of the social order, of the ends of Government, of the fundamental moral law, in all we do and all we seek, let us act under the banner of *Justice*. Beneath its broad and benign cloak we may be assured that not only life and liberty, but property, individual and corporate, and in every form in which it can lawfully exist, shall be doubly safe against every invasion, not warranted by the law of the land. For every man imbued with the spirit of *Justice* understands that the law of the land is equality of legal rights, which no man is too high and no man too low to share in; that this principle is the Ark of the American Constitution—the very object of its foundation—and that in order to maintain and defend it, it is the duty of all its loyal votaries to join hands in an unbroken and indissoluble bond to cherish the proud traditions of their

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inheritance and to stand fast by the Covenant of the Fathers.

THE PRESIDENT: Now, the usual order would be to receive at this morning session the report of the Nominating Committee.

MR. LATHROP: Mr. President, I would say that the Committee held a short meeting last night, but took no definite action in view of the suggestions which we expected would be made to the Institute this morning by the Board of Directors, and the changes which we thought would probably be adopted by the Institute in the Constitution. So we will have to ask for more time in which to make a report.

THE PRESIDENT: The Nominating Committee desires then to report at some later hour?

MR. LATHROP: Yes, sir.

THE PRESIDENT: As the hour for recess has come, the first business of the afternoon will be the discussion of the admirable paper that we have just heard. We will reconvene at two o'clock.

The Institute adjourned to 2 P. M.

FIRST DAY.—AFTERNOON SESSION.

The Institute was called to order at 2.15 P. M., Mr. Prichard in the chair.

DISCUSSION

OF MR. DICKEY'S PAPER ON THE OBLIGATIONS IMPOSED BY THE POSSESSION OF A FRANCHISE.

MR. PAUL DOTY: Mr. President and Gentlemen of the Institute: The Institute is to be congratulated upon the presentation of the scholarly address Mr. Dickey has given to us. Those who know Mr. Dickey's modesty as I do, know that he needs no words of praise from me.

But I do want to congratulate Mr. Dickey upon the tolerance of thought, and the ideas which he has presented. If I were to criticise the paper, the only thing which occurs to me is to mention the absence of technique, but I am sure each gen-

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tleman from his own experience can supply all omissions of that nature. It is appreciated that an address of this kind necessarily is general in its application. If there is anything omitted referring to the conditions of one's own franchise, it is only necessary to consider one's own franchise to bring a realization of what may have been omitted.

So far as franchises are generally concerned from the city's point of view, the interest of the public lies primarily in good service and fair prices. When I used the word "franchise" above, I mean the franchise to do business, or the license, so-called. It is appreciated that franchises are of two kinds, one the right to be a corporation, which is a franchise granted by the State, and the other a franchise or license granted by the city. Although Mr. Dickey does not differentiate between the two, I have no doubt he had that thought in mind, but Mr. Dickey emphasizes the feature of the franchise imposing upon us the obligation to give good service at a fair price. I would emphasize the meaning of good service. It is treating the public fairly and justly, extending the gas mains to give to the people of the city the convenience and comfort of the use of gas, and to make gas for distribution of a good quality. Some franchises have provisions specifying the candle power requirements, and perhaps later on will contain provisions specifying the heating value of the gas. Many franchises have other provisions such as not to be a burden to the streets, to be responsible for damages, and in many other ways fully protecting the city's interests.

What is a fair price is a large question, and naturally cannot be discussed here, for a fair price, as was said of the tariff, is a local issue.

I think we are drifting away from the idea of municipal ownership as being impracticable and un-American, and of no advantage particularly to the public. Regulation of private corporations is of far greater interest to the public, and the latter can be depended upon to take good care that the franchise obligations we have undertaken are fulfilled.

I am glad Mr. Dickey has made reference to the fact that obligations rest upon the people as well as upon the corporation.

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I think this is quite important, for the stockholders, the owners of the property, are entitled to reasonable protection. The stockholders are entitled to the fullest measure of security for their investment, and this I would emphasize. If the public require us to invest our capital to make extensions of mains and to run services, and in addition have adequate capacity for manufacturing to furnish a good quality of gas, and have inspectors to see that the measurements are correct, all of which burdens they have put upon us, we certainly have the right to ask that our franchises be secure from attack by raiders or ill-advised municipalities which threaten the security of the investment. Just how this security of investment is to be obtained is a broad question, and is a matter of technique hardly to be discussed from the floor of the Institute. I think we are all agreed that we ought to have the legal rate of interest on our investment in public service corporations, and how much more we ought to be permitted to earn than the legal rate of interest is a question. Some would advocate at least double that amount. I think myself this is none too much. This is especially true in view of the risk and hazardous nature of our business, so it is not enough to earn simply the amount to be paid in cash to the stockholders. A good rule is "a dollar for dividends, and a dollar for surplus" from the earnings. The surplus may be in the nature of a sinking fund for short-term franchises, or a reconstruction reserve, or a fund for liability insurance; that is, public liability insurance, or any of the other elements of risk which we are apt not to include in our reports. We are too often inclined to include in operating expenses the mere items of manufacture, distribution and sale; perhaps we include an item of general expense, but this does not include all of the contingent items of which I have made mention. The public consequently get an exaggerated idea of the profits of the corporation, simply because we show the returns greater than they are. Perhaps this practice has grown from a desire to sell stock or to make a manager's record, and the public cannot be blamed for taking in the viewpoint of the company. The municipality is very apt to take us at our own valuation.

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Mr. Dickey has called attention to the contract relations existing in a franchise. This goes without saying, for franchises have been interpreted to be contracts. You can rest assured that the public will see that its end of the bargain is carried out so far as the obligations of the company are concerned, but the difficulty has been to get the public to see that their end of the bargain ought to be likewise carried out.

Mr. Dickey presents the idea of "service" for the public-service corporation. Now, I like the expression of this idea, and I think it truly tells us what our business is. Our business is one of service. Mr. Dickey has made use of admirable language which it will pay us to read, as to what constitutes service. Service to the public recognizes to the fullest that we are not working for the corporation alone, but serving the people from whom the corporation gets its rights and privileges. I would like to dilate more on that, but the paper will be in your hands. I would like to emphasize the appeal for co-operation. I have said on other occasions that co-operation and corporation were related terms. We want co-operation. We want to have the co-operation to maintain the balance that is so necessary between our relations to the public and the relations to our employers; and the manager, superintendent or engineer, who can bring about the greatest degree of co-operation between the public, the newspapers, the co-operation of the stockholders and the employees, and the man who can harmonize all of these various elements for mutual advantage, is the man that will have the greatest measure of real success. (Applause.)

THE VICE PRESIDENT: Is Mr. Doherty in the hall? I would like to hear from Mr. Doherty if he is disposed to favor us.

MR. H. L. DOHERTY: Mr. President, I will have to ask to be excused. I was not here when the paper was read entirely. As I understand, it is on Mr. Dickey's paper.

THE VICE PRESIDENT: Yes.

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MR. DOHERTY: I will have to ask to be excused. I am sorry I am not prepared to talk.

MR. J. J. BURLEIGH: Mr. Dickey's paper was interesting to you, particularly as showing what a patient, long-suffering man the gas man is. When he has got that one-sided contract. the franchise, talk well of it. After years and years of well doing, he enjoys being told to keep on doing well. We are to come all the way to Washington to be told in a delightful paper that, notwithstanding the other fellow's failure, the man on the other side of the contract, that we must keep on giving, keep on trying to please them, no matter what the demands may be; that having turned one cheek and having it wounded we are to turn the other to them until both are sore. How long will we keep on doing it? We have almost reached the limit of endurance in some localities. His experience with the public is delightful. It has not been mine. His experience with the newspapers is positively unique. I never had anything like it.

THE VICE PRESIDENT: Does any other gentleman desire to offer any remarks on this paper? If so, now is the opportunity.

No one else caring to speak the matter will be closed and we will take up the next matter which is on the program, "Depreciation," by Dr. A. C. Humphreys.

DR. A. C. HUMPHREYS: Mr. President, and Gentlemen: I am sorry to say that the paper I have prepared is extremely long. I have asked for suggestions from the management as to whether I better abstract it or not. I have received no such suggestion, and, therefore, it is not done. I shall, however, endeavor to skip if I find there is any place where I can do so to advantage.

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DEPRECIATION.

By Alexander C. Humphreys, New York.

It is intended that this paper shall supplement the paper I presented at the last meeting of the New England Association of Gas Engineers under the title—"The Present and Growing Need for the General Adoption of a Uniform System of Records and Accounts."

In that paper I stated that what I had to say was intended as a warning and an appeal and that "the day had passed when secrecy as to our accounts can be depended upon for our protection from misapprehension and misrepresentation. Secrecy necessarily leads to suspicion on the part of those not in the secret. To this proposition we must submit in spite of the fear of legislative 'strikes.'" I especially drew attention to the records and accounts published by the Massachusetts Commission and, in that connection, I pointed out that, in spite of appearances, they were strikingly incomplete and lacking in that uniformity requisite to conclusive comparisons and, hence, the dangers to be apprehended from such official reports when used by those whose object it was to misinterpret data in connection with attacks on gas companies and, especially, if so used by men who, if expert in no other way, were expert in the line of such misinterpretation and misrepresentation.

Let it be at once conceded that it is extremely difficult to devise a uniform system of accounting as applicable to any one industry; it is still more difficult to secure a uniform interpretation and application of any rules that may be laid down. In fact, anything approaching perfection as to final result is doubly difficult through variation in conditions and the unwillingness of managers and accountants to accept someone else's opinion in place of their own. And going still farther, if the conditions locally were uniform and each and every accountant concerned were determined loyally to work according to a

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uniform system, the records would still not be absolutely comparable by reason of the unintentional variations in application of the rules introduced through the personal equation.

This is true with regard to the more routine matters which have to be interpreted in connection with accounting. How much more then must it be so with regard to the treatment of depreciation which must finally rest upon expert judgment.

This all may seem to suggest that it is useless to attempt to obtain a uniform practice in our records and accounts and, especially so, as to depreciation. Not so, to my mind. The more we strive to develop and maintain a uniform system of accounting, including depreciation, the more we all must be impressed with the danger of blindly accepting for comparison, data on its face value—that is, without careful analysis—and the better equipped we will be to meet the dangers to be apprehended from the efforts of men paid—liberally paid—to misrepresent us through partial and distorted applications of figures derived from undigested records. For here we must not forget that these men may take separate items out of their context and use them only for the purpose then in mind, and go so far perhaps as to use the same items for contradictory demonstrations if necessity demands and opportunity warrants.

The foundation of all effort to establish and maintain a uniform system of records and accounts should be absolute truthfulness and consistency. Here at once we would be in opposition to the work of some of these so-called experts, for their work is too often based upon inconsistency.

The American Gas Light Association, of which this Institute is the successor, adopted a uniform system of accounting. In the paper read before the New England Association, as previously mentioned, I referred to this work of the American Association as follows:

"During the year 1902 a committee of the American Gas Light Association, appointed two years before to report on a uniform system of accounts, brought in its final report. I had the honor to be Chairman of that Committee. The Committee worked conscientiously through two years and brought in its

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conclusions subject to certain modifications which might be made as a result of additional suggestions immediately thereafter to be made by the members through the mail. A few months later, the report of this Committee was published, and, in accordance with a resolution of the American Gas Light Association, was adopted as its standard uniform system of accounts.

"There was one radical defect in this report and that was the omission by the Committee of a definite recommendation on the question of depreciation. This was not due to an opinion on the part of any member of the Committee that depreciation should not be cared for. But there were differences of opinion in the Committee as to whether that was a matter with which the Committee had been charged to deal.

"The Committee rendered a report of progress at the meeting of 1901 and the draft as at first prepared contained a very decided pronouncement in regard to the necessity of caring for depreciation in a methodical way. All the members of the Committee were not present at this meeting and it was, therefore, impossible, in view of differences of opinion, to render the report in this form. Later, the Committee failed to agree on a statement to cover this most important subject and, under the pressure to complete the work within the promised time, the subject was unwisely, I now confess, pushed to one side. Personally, I have never ceased to regret that the Committee did not agree upon some statement in this connection and that, failing to agree upon a definite statement, the members of the Committee did not at least recommend that the matter be further considered and request that the subject be recommitted to enable the Committee to complete its work in this regard."

Finally, I recommended in this paper that the New England Association should interest itself in the establishment and maintenance of a uniform system of accounts, including uniformity of practice, as far as possible, in caring for depreciation and that the New England Association should co-operate in this matter, especially with the Gas Institute.

As a result of this recommendation, the New England Association appointed a committee to consider this whole ques-

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tion, especially in connection with representatives of the Gas Institute.

I trust that at this meeting action will be taken to reconsider the whole question of uniformity of accounts and records and especially with regard to depreciation.

The system which now bears the endorsement of the American Gas Association can well be taken as the basis for such action and, upon this foundation, can well be built a scheme capable of relieving the gas men of America of many embarrassments in these strenuous and troublous times; but this result cannot be reached unless the subject of depreciation is cared for as well as may be under the conditions so hard to meet.

Outside of depreciation the system as now adopted hardly needs revision except to better meet the demands involved in returns to governmental commissions.

To those of you who may be inclined to think that too much stress is being laid upon depreciation, I would say that, if you have to appear before a State Board, which interprets its commission to mean that where complaint is made, its duty is to cut down prices regardless of local conditions and the facts in general, you will find that, if depreciation has not been regularly charged as an item of expense, the Commission will take the position that, as there has been no such charge regularly made, there is no such item of cost or the cost of depreciation has been covered by the payments for current repairs and renewals. Nor will this acceptance of the Company's accounts in the one instance prevent those sitting in judgment from cutting out other items of cost upon the testimony of partial or ignorant "experts."

If the men before whom our interests are on trial are politicians, as too often is the case, they are, according to the present fashion, listening more attentively to the voice of the public than they are to the evidence, though they welcome the "expert" evidence which favors a decision against the defendant company.

This all means that common prudence dictates that not only must our accounts give the truth, the whole truth and nothing

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but the truth, but they must be so constructed as to show the facts plainly, with the least possible need of explanation, and in every possible way be safeguarded against misinterpretation.

A concern operating a private business, subject to no outside supervision or control, may show its Profit and Loss account and Assets and Liabilities in any way agreeable to the proprietors. But if, in conducting our business, we are to be subject in any measure to the control and supervision of men who most likely will be ignorant as to our business and perhaps as to all business affairs, and probably incapable, through lack of training, of comprehending the fine points of accounting, and if these men have the power, *prima facie,* to fix the price of gas, and in doing so to pass upon the cost of gas and the amount of capital required, using our accounts as far as possible as weapons against ourselves, then certainly this subject of accounting is one which we cannot afford to treat in any but the most serious way.

The Massachusetts Companies have largely followed a practice in regard to book valuation of assets which is to-day working an injury to all the companies of the United States. The practice is by no means confined to the Massachusetts Companies but, by reason of the publicity given to their accounts through the reports of the Massachusetts Commission, which reports are neither complete nor self-explanatory, the practice as followed by these Companies works a general injury to our business.

In this connection I cannot do better than quote from my New England Association paper:

"Comparing certain four Massachusetts Companies with New York, which Professor Marks claimed to be fairly comparable with New York, he showed a structural value of $1.78 per thousand of annual sales. (This should have been stated per annual thousand cubic feet capacity instead of sales—an ingenious device of Marks for reducing the apparent required capitalization). It perhaps will require a Massachusetts gas man to appreciate fully the absurdity of the analysis by which the last figure was obtained.

"My analysis of the individual reports of the companies re-

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ferred to as found in the appendix showed the *capital* of these companies to be respectively $2.38, $2.29, $2.01 and $2.04. But the book assets, fixed and working, were $3.96, $3.50, $3.24 and $3.40. Understand, these were the book values of assets. Now, I made a further analysis and compared the book values of mains and meters with the values as derived from the schedule of those assets, and using moderate valuations for the meters, and using for the mains a valuation which Professor Marks had stated as applicable to work outside of city limits, *which allowed for no expensive pavements,* I found that the corrected assets for the first three were respectively $4.38, $3.80 and $4.38; the last one I was unable to correct because the assets were not divided on the balance sheet. It is also to be noted that a full correction was not made because there were no schedules of services and manufacturing plant. It is reasonable to suppose that a complete correction, including these two divisions of plant, would have increased the difference between actual and book values.

"This brings me to a point which is very noticeable in the Massachusetts accounts and which, I submit, requires careful consideration at the hands of the Massachusetts Companies and the Massachusetts Commission. Professor Marks particularly referred to the structural assets of one Massachusetts Company in connection with some of his analyses. An analysis of the statements of this Company showed that, during a period of five years, there had been a *decrease* in the *book* valuation of mains of about 9 per cent., whereas the actual value derived from the schedule had *increased* almost exactly 30 per cent.; and, furthermore, that the actual value at the first of the period was 3½ times the book value. This unquestionably is an extreme case, but it goes to demonstrate that the book value of fixed assets, as shown by the Massachusetts Companies in their published reports, do not indicate by any means the actual investment in those assets. And here it is to be appreciated that men like Professor Bemis and Professor Marks go on the stand, avail themselves of these published records and, from these records, make the argument that the amounts shown by the Massachusetts Companies as capitalization per

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thousand or assets per thousand are a safe criterion in the case of other companies. In other words, they claim that because they find a certain company has a book valuation for structural assets of, say, $2.00, that figure can be safely assumed as the cost of the plant necessary for the supply of a district conditioned somewhat similarly, and furthermore, it requires cross-examination to bring out the acknowledgement that, in addition to these structural assets, an allowance must be made for working or active capital; and, furthermore, as I have shown, unless the returns as published are perfectly self-explanatory, such a man as Professor Marks can appear on the stand and claim that the active capital should not exceed 13 cents a thousand, although the very records from which he is drawing his conclusions show, if completely analyzed, that there is required 43¾ cents per thousand.

"Again 'experts' of this kind refer to the Massachusetts Reports and, making convenient selections, show a very low capitalization per thousand of annual sales and then argue that this should establish the maximum upon which other companies should be allowed to pay dividends. The average capitalization of the thirty-two Massachusetts Gas Companies engaged exclusively in the gas business, according to the 1906 Report, is $2.88 per thousand of annual sales. But I have already shown how the actual capital invested in fixed assets plus the working capital is far in excess of the capital, including stock, bonds and notes payable, so it is again seen how the Massachusetts Companies in their reports as published by the Gas Commission furnish a most misleading comparison in the hands of incompetent or designing men."

* * * * * * * * *

"The prudent New England industrial manager inclines to a liberal writing down of the book value of assets. If a concern owning a cotton mill or a shoe factory wishes to carry a $500,000 plant on its books at a nominal valuation of $100, simply to keep the account open, that is nobody's business except the owner's. But the proposition is very different in the case of a public service corporation subject to investigation and control.

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"Even such a policy of writing down of assets as has generally been followed by the Massachusetts Companies, partly of their own volition emanating from this New England prudence and partly under pressure from the Gas Commission, is unjust to the stockholders of other United States companies.

"The money actually invested and employed in the business should be shown in the asset accounts and should be represented by capital."

In connection with this quotation, it is to be borne in mind that the experts opposed to us aim to show an impossibly low rate of investment, argue for a low return on investment, manipulate their figures in every possible way to produce a low cost at the burner and then claim that the price for gas should be the amount obtained by adding the low return on a low rate of investment to the impossibly low cost at the burner.

In the above quotation from my New England Association paper, reference is made to two "experts" who have been prominent in the recent New York City and State gas hearings and litigation. Professor Edward W. Bemis is familiar probably to all of you, at least by name, for he has been engaged for many years in the business of interpreting such data as he was able to collect, so as to reduce the value of gas properties, except in the one case of Baltimore, where he attempted, as the City's expert, to increase plant value for the purposes of taxation.

As you also probably know, Professor Bemis endeavors to qualify as a gas expert though, if ably cross-examined, he has to acknowledge that he has had no actual experience in the gas business. In the later cases he has been practically relegated to the position of a statistician, and he certainly is an adroit one.

In the recent case of the Buffalo Gas Company before the New York Commission of Gas and Electricity, now happily legislated out of office, both Professor Bemis and Professor Marks appeared against the Company. I appeared for the Company as its president and as expert, and so again had opportunities to observe the methods followed by these "experts."

Although pretty well convinced that it would have no influence on the Commission, we decided to cross-examine Bemis

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as to his knowledge of the workings of several parts of a gas works. He acknowledged he never had made gas; never had superintended a gas plant; never had laid any gas main, but had laid over 100 miles of water main. When asked the difference between a compensator and a governor, he answered: "I won't attempt to go into technicalities." When asked whether naphthalene was a high temperature or a low temperature product, he replied: "Well, I am not specially acquainted so that I would want to testify on that. I have read a great many things upon that subject in Newbigging and other books but I do not claim to have practical knowledge." To the question: "How does a standard washer operate, what are its functions?" he replied: "Well, that again I do not claim to be a specialist on. Of course, it is for taking out many of the impurities." The further question was then put: "What do you claim to be a specialist on in connection with the practical manufacture of gas?" and he answered: "I am pretty well acquainted with the statistical side."

About twenty questions were put to Professor Bemis later, as to the every-day procedure in connection with the operation of a gas works, which he was unable to answer.

After Bemis had thus failed to qualify as a gas expert, Commissioner Davies (former attorney-general of New York State) who was presiding, addressing our counsel, gave his ruling as follows:

"Well, we think you have qualified him and we will overrule your objection."

What a commentary on Commission control!

Professor William D. Marks is probably not so well known to you by name as Professor Bemis although, unlike Bemis, he has had some connection, even if limited, with our business. According to the testimony in the Buffalo case, he was engaged in 1872 in the building of the Laclede Gas Works in St. Louis—this about a year after he graduated from Yale. Had nothing to do with the design of the Laclede Works. Never operated a gas works as manager. Subsequent to 1877, his gas experience was limited to a little plant in Fostoria and to the plant in Durham, N. C. Finished with Durham about five

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years ago and has had no connection since with gas works, either as to operating or in an executive capacity.

Having omitted to include in his appraisal schedule a compensator, he was cross-examined as to his reason for so omitting this part when other less important parts had been included, he stated he had not observed the part referred to and, finally, when pressed to describe it or its function, he acknowledged that he did not know what a compensator was, and added (page 594): "If you will show me a picture of the thing you are talking about, I will tell you at once."

On page 258 Marks mentions as an item in his schedule of qualifications as an expert, that he is the author of "The Finances of Gas and Electric Light and Power Enterprises." On cross-examination (page 386) he states he has no reason to change his views in regard to it—that is, as to the accuracy of its matter. When confronted with the statement repeatedly made in his book that 15 per cent. on the investment should be allowed for interest and depreciation (generally 10 per cent. for interest and 5 per cent. for depreciation—in a few cases 8 per cent. and 7 per cent. respectively) he repudiates the book and states he has since had reason to change his views in some particulars (page 575).

Since the New York and Buffalo cases have been heard, Marks has published the fourth edition of his work on Finances. In the preface to this latest edition, no doubt with this and other cross-examinations in mind—for this book of his has always been brought up against him as to return on capital and depreciation—appears the following paragraph:

"The suggested 15 per cent. of profit and depreciation given in some cases is only a suggestion. In large concerns 10 per cent. or less is often used."

The last paragraph of this preface is too good to escape special notice, especially when we are dealing with the subject of depreciation, and as Professor Marks particularly claims to be an expert on this subject:

"The very commendable determination to reform these deplorable conditions, which is to-day being evidenced in our legislation for the control of quasi-public corporations is en-

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tirely proper, provided this legislation is not that of the inexpert in the subject with which it deals. Regarded from the point of view of the higher laws of nature of which there can be no evasion and from which there can be no appeal, the evil results of a blunder are quite as serious as those of a crime. I hope that this little work will be of service by presenting a rational and practical analysis of the true cost and true profits of these corporations, and in preventing blunders on the part of reformers actuated only by the best of motives."

I advise each and every one of you to own a copy of this latest edition of Marks' book. It may be of value to you, if the author appears against you. The price is $4.00 postpaid. No publisher is mentioned, so I presume you may order direct from the author—William D. Marks, 623 Park Row Building, New York City.

In this last edition, the first ten chapters, comprising 361 pages, are page for page the same as the older edition; there have been added five new chapters. This new edition, therefore, includes all of Marks' former statements and allusions in regard to 15 per cent. on the cash investment to be allowed for depreciation and profit, including a table of "Gas Companies of Mass., 1901 Report" (pp. 218 and 219) in which a column appears headed "15 per cent. depreciation and profit per 1,000," under which the amount of 15 per cent. in dollars per thousand is entered for forty-one companies.

The new chapters are as follows:

Chapter XI. Cost of Street Lighting, which deals entirely with estimated cost of municipal arc lights in Philadelphia, in which he allows 7½ per cent. on investment for cost of depreciation, in addition to 2.7 per cent. for maintenance and repairs of lamps or a total of 10.2 per cent. for depreciation and repairs, and then 3½ per cent. for interest on investment.

Chapter XII. Prices of Gas and Electric Light in New York City, 1906, in which the author deals with the formation of the Consolidated Company *from the author's standpoint.*

The following quotation is from the closing paragraphs of this chapter:

"The hearings of the State Gas and Electric Light Commis-

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sion are still going on and the employes and experts of these gas companies are doing their best to swell the cost of the production of gas." . . . "Like preceding Commissions, this Commission is accepting the figures furnished by the gas companies; consequently its *conclusions will not carry any greater weight than those of its predecessors.*" As stated, this was written before the Commission had made its ruling reducing the price to 80 cents. Marks did not testify in the New York Gas Commission case, though he did later in the United States Circuit Court case, where his testimony was apparently not taken seriously by Master Masten. If Marks had had his Buffalo experience before the New York case and before writing this chapter of his later edition, he probably would have been more hopeful of the results to be obtained from the New York Commission.

Chapter XIII. The Cost and Selling Price of 22 Candle Power Gas to the Consolidated Gas Company of the City of New York Marks' digest of the New York case before the Master is in marked disagreement at almost every point with the findings of the Master, a man noted for his ability and fairness in interpreting expert testimony.

The Master in his report refers especially to Marks' lack of experience as a gas engineer and manager. The author makes a number of references to my testimony in this case, and in doing so misrepresents me.

On page 413, he says that I acknowledged on the stand that I had not examined the vouchers and accounts of cost "but had blindly accepted the figures furnished by the officials and employees of the Consolidated Gas Company." This statement is untrue. I did not so testify, but I did say that I had not made a complete audit, including the critical examination of each and every voucher. The fact is, I had spent months on the examination of the accounts before presuming to testify.

On pages 449, 450, he states that, under cross-examination, I was forced to recede from certain figures I had given in a table as to structural cost of certain Massachusetts Companies. The facts are that I was requested by the counsel for the City, then cross-examining me, to abstract certain figures from the

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table and combining them with others of his own to make certain independent computations therefrom, thus producing the figure of $1.86, as Marks says, but, as Marks was himself in the habit of saying on the stand, this I did as the examining counsel's computer. The figures as selected by counsel gave a result which was inconclusive, and in no way contradicted my testimony as given.

Again, on page 450, Marks says that I confessed that I had used a chart of his improperly. This is absolutely opposed to the facts. The chart was one prepared by Marks to show by separate and distinct curves the cost of laying pipe of various sizes under various conditions. The curve which I had used from Marks' table to rebut his own testimony was distinctly labeled, "Cost per foot for Streets with Macadam Tops outside of City proper, laid and surface restored," and the prices taken therefrom for the different sizes of pipes as used by me were low and eminently fair for the purpose to which I applied them. A copy of this chart will be found facing page 456, and immediately following another chart which Marks used in the Buffalo case. Now let us see how Marks used this latter chart in Buffalo. On this chart we find several curves, one covering cost per foot of pipe laid without pavement, another for cost per foot for streets in City proper with stone or macadam pavement, another for streets in City proper with brick, asphalt or block stone on concrete, and still another for cost per foot for rock excavation at $5 per cubic yard. At the foot of the chart we find a note to the effect that "figures include 10 per cent. undistributed expense and 15 per cent. contractor's profits." When Marks was *cross*-examined as to his valuation of mains in Buffalo, he would immediately refer to this chart which was obviously calculated to give the impression of great fairness and as having covered fairly all the different kinds of pavement, rock excavation, etc., etc.; but under the pressure of the searching cross-examination it was finally brought out that *the only curve on the chart which he had made use of was the one which showed the lowest cost*, namely, "Cost per foot for pipe laid without pavement." After much difficulty we were able to get from him in figures the actual costs per

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foot which he said he had used. It was then found that using these figures and the accepted schedule of lengths did not produce his final result. There was a shortage of $191,273.70. When this discrepancy was disclosed by me in my testimony, it was explained (page 1293, Buffalo Record) that it was due to Marks having eliminated the 15 per cent. contractor's profit and, upon further analysis, it was found that he had not only eliminated this 15 per cent. but, in doing so, had made the mistake of multiplying by 15 per cent. and subtracting, instead of dividing by 1.15, making a further difference against the Company of $24,948.

As a further commentary on Marks' chart—which appears so well typographically in the little book—and of Marks' methods on the stand, let me give a single example from the Buffalo chart. It will be found that for 20 inch "pipe laid without pavement," the figures interpreting the curve are $2.83 per foot. Now, if we eliminate the 15 per cent. contractor's profit, which is *included* in chart and which Marks *excluded* in his final figure, we have $2.46 per foot. As was shown in our testimony, the cost of the pipe on the cars at Buffalo *at the time Marks gave this testimony was* $2.47½ or 1½ cents more than Marks had allowed for the pipe laid, ditch filled and pavement, if any, replaced.

But I could continue far beyond the point where your patience would be exhausted to show that Professor Marks' digest of the New York Consolidated case cannot be safely accepted. It may be sufficient to remind you that the contentions as made by Marks *are in many cases in detail refuted by the Master's report.*

Already you may be wondering why I pay so much attention to Professors Bemis and Marks in connection with my present paper, and especially in connection with their testimony outside the subject of depreciation.

I think that all that I have said is pertinent.

By the way in which the public, the Commissions, even the courts and, particularly, the yellow journals are attacking our industry, we must be prepared to meet these attacks and to meet them squarely with the facts. When the attacks assume

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definite form, our opponents will be assisted by Professors Bemis, Marks, or men of their type. It is, therefore, of the utmost importance that we should all be informed as to the methods these men pursue and, especially, is it important that we all should be put on our guard not to accept any statements such as those made by Marks in his book without careful analysis of the original records. Especially is it important that those of us who have not had experience in these investigations and attacks should know that there are certain records which may be helpful in meeting the attacks of these "experts."

All of this especially applies to depreciation because of the intricacy of the subject.

Let us for a moment consider the methods of the two "experts" named in connection with the subject of depreciation. Professor Bemis' method seems to be to quote from some well-known gas man's testimony in connection with some particular case and then apply to the case in hand the data so obtained, if such meets his requirements. He has honored me by quoting me in several important cases and, in doing so, has first fully qualified me so as to give his data value. For instance, in the Chicago case, he quoted from my Holyoke testimony, made certain corrections which were absolutely unwarranted by my testimony and then applied the resulting figure to Chicago, irrespective of what differences there might be between the local conditions of Chicago and Holyoke, the difference as to accounting, the difference as to amount spent for repairs and differences as to design and character of construction. In this and other cases he intimates that my testimony was for general application, whereas I have never testified as to any depreciation figures for general application and, in the Holyoke case, I repeatedly went out of my way to emphasize the fact that my testimony was applicable only to Holyoke, and was not for general application.

In the Syracuse and Buffalo cases, Bemis worked on my Holyoke life table, prepared seven or eight years before, and then applied this table in his own way, irrespective of change of conditions due to locality, date, character of construction, methods of operation, etc. Having established such an aver-

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age life to meet his present requirements, he then determines the rate per cent. required to produce through a sinking fund $100 at the end of the assumed life, and this per cent. he applies to his *assumed* structural value of the plant under consideration. In other words, he always works on the sinking fund basis and assumes 4 per cent. or 5 per cent. for the rate of interest to be obtained through the whole term of years. Under the present abnormal conditions of high rates of interest, if he were testifying, it would not surprise me if he assumed 6 per cent. as obtainable for a life of 30 or 40 years to come.

It is particularly to be noted that Bemis takes the amount required by the sinking fund scheme as *the actual cost of depreciation.* Of course, such is not the fact. If we have a certain piece of apparatus which we estimate will have to be discarded at the end of 40 years, in spite of the fact that it is to be kept in as good condition as possible during those 40 years, then the annual cost of depreciation over and above the cost of repairs and maintenance is one-fortieth of the original cost, always provided we assumed the apparatus will have no value when discarded. If we estimate that it will have a certain value at the end of the period, then, of course, the annual cost of depreciation will be one-fortieth of the difference between the original cost and the residual value.

Others besides Professor Bemis have fallen into error by failing to distinguish between the cost of depreciation and the financing of this item of loss.

If we decide to meet the loss by a fixed annual payment less than the amount of annual loss, relying upon the interest accumulations on these payments to make up the difference, that does not reduce the actual operating cost of depreciation but simply provides that the interest on these payments, which otherwise would be applicable to other purposes, is to be devoted to meeting depreciation cost.

This is well exemplified in Professor Bemis' testimony in the Buffalo case.

Bemis testified that, in addition to the amount charged up for repairs and maintenance, he allowed 5 cents a thousand to

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cover depreciation, making 11 cents in all for repairs and depreciation.

When his life table (taken from my Holyoke testimony of years before) was developed in connection with the property appraisal estimate of his associate, Professor Marks (later to be referred to), he found that, by reason of the absurdly low valuation given by Marks, his life table gave only 3.55 cents per thousand, instead of the 5 cents which he previously had given as the correct figure. He then endeavored to justify his 5 cents estimate and make it tie in with the 3.55 cents developed from his life table as follows: (page 667) "I can add 40 per cent. to that (the 3.55 cents) before I reach the 5 cents which I allow, which is the same as saying that it will reach 5 cents on giving the plant a value of 40 per cent. greater than Professor Marks *assumed,* or nearly one million dollars greater.

Therefore, there is a margin allowed for error of Professor Marks' of one million dollars." This seems to be quite a concession on the part of a sustaining witness, but the fact is, Marks was a good many millions below the truth.

Bemis assumed a 5 per cent. rate of interest for his sinking fund, as he says, "because it is generally considered in the gas business that money put into plant ought to produce 5 per cent. return." This clearly indicates that, although his small charge for depreciation cost is based upon the amount required to be deposited in a sinking fund to accumulate interest, and a 5 per cent. sinking fund at that, he acknowledges that the necessities of the business will require the depreciation fund to be reinvested in the business. Here, then, he overlooks or conceals the fact that, if the depreciation payments are reinvested in plant for extensions, etc., the interest accumulations as covered by the sinking fund scheme, must necessarily come out of the earnings of the business, and so it is at once shown that the total loss by depreciation must fall upon the business as a whole. If the depreciation fund is reinvested in the business on the theory that such reinvestment of income will meet the cost of depreciation, then certainly the additional earnings from such reinvested income must be segregated and appropriated absolutely as an offset to depreciation loss—otherwise, the whole scheme falls to

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the ground. But how can these individual earnings be identified, segregated and then combined to meet this demand? An accountant will at once see that the problem is one of great intricacy and anything gained fails to compensate for the trouble and expense of such a complication in our scheme of bookkeeping. It remains then to assume such a rate of return as we feel sure these reinvestments will secure in our business, and then, feeling reasonably sure that the general earnings will include these additional earnings, set apart the required amount against depreciation without attempting to indicate which particular dollar is earned by original investment and which by the items of reinvested income.

If we still desire to follow the sinking fund scheme in connection with such reinvestment of depreciation fund payments, so securing a minimum annual payment *at the first,* we can set up a sinking fund scheme on our books and make the payments accordingly. But even this introduces an unnecessary complication, and there is nothing to warrant such a course except this desire to reduce the amount of original annual payment and, perhaps, the hope that by so doing directors who are naturally anxious to make a return to their stockholders on a halting investment may be more readily induced to care for this depreciation loss, which is more or less elusive and intangible in its character, though, in the long run, very real and insistent in its effect.

In connection with some letters published in "Progressive Age" (March 1 and April 2, 1906), I discussed this part of the depreciation problem and I showed in a table the annual payments which would thus have to be made on the basis of a 40 year life of plant, sinking fund scheme 4 per cent. This table I here reproduce with additional columns showing the annual payments under a 5 per cent. sinking fund scheme, such as Professor Bemis adopted in the Buffalo case, as above referred to.

Here it is at once seen that while according to the 4 per cent. scheme it requires only $1.05 for each $100 the first year, the 40th payment calls for $4.847 or $3.797 in addition to the $1.05, which $3.797 is the interest accumulation to be met for

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RESULT OF COMPANY OPERATING ITS OWN SINKING FUND AND THUS HAVING TO PUT UP PRINCIPAL AND INTEREST.

40 YEARS LIFE. YEARLY PAYMENTS PER $100 TO INCLUDE COMPOUND INTEREST ACCUMULATIONS AS OBTAINED FROM EARNINGS.

YEARS	4% COMPOUNDED ANNUALLY. Amount annually required to accumulate $100 in a 4% Sinking Fund at end of 40 years is $1.05.		5% COMPOUNDED ANNUALLY. Amount annually required to accumulate $100 in a 5% Sinking Fund at end of 40 years is $0.83.	
	$1 Compounded at 4%.	YEARLY PAYMENTS, being 1.05 multiplied by number in preceding column.	$1 Compounded at 5%.	YEARLY PAYMENTS, being .83 multiplied by number in preceding column.
1	1.0000	1.0500	1.	.83
2	1.0400	1.0920	1.0500	.8715
3	1.0816	1.1357	1.1025	.9151
4	1.1249	1.1811	1.1576	.9608
5	1.1699	1.2284	1.2155	1.0089
6	1.2167	1.2775	1.2763	1.0593
7	1.2653	1.3286	1.3401	1.1123
8	1.3159	1.3817	1.4071	1.1679
9	1.3686	1.4370	1.4775	1.2263
10	1.4233	1.4945	1.5513	1.2876
11	1.4802	1.5542	1.6289	1.3520
12	1.5395	1.6165	1.7103	1.4195
13	1.6010	1.6811	1.7959	1.4906
14	1.6651	1.7484	1.8856	1.5650
15	1.7317	1.8183	1.9799	1.6433
16	1.8009	1.8909	2.0789	1.7255
17	1.8730	1.9667	2.1829	1.8118
18	1.9479	2.0453	2.2920	1.9024
19	2.0258	2.1271	2.4066	1.9975
20	2.1068	2.2121	2.5270	2.0974
21	2.1911	2.3007	2.6533	2.2022
22	2.2788	2.3927	2.7860	2.3124
23	2.3699	2.4884	2.9253	2.4280
24	2.4647	2.5879	3.0715	2.5493
25	2.5633	2.6915	3.2251	2.6768
26	2.6658	2.7991	3.3864	2.8107
27	2.7725	2.9111	3.5557	2 9512
28	2.8834	3.0276	3.7335	3.0988
29	2.9987	3.1486	3.9201	3.2537
30	3.1187	3.2746	4.1161	3.4164
31	3.2434	3.4056	4.3219	3.5872
32	3.3731	3.5418	4.5380	3.7665
33	3.5081	3.6835	4.7649	3.9549
34	3.6484	3.8308	5.0032	4.1526
35	3.7943	3.9840	5.2533	4.3602
36	3.9461	4.1434	5.5160	4.5783
37	4.1039	4.3091	5.7918	4.8072
38	4.2681	4.4815	6.0814	5.0476
39	4.4388	4.6607	6.3855	5 3000
40	4.6164	4.8472	6.7048	5.5650
		$99.7769		$100.2637

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that year. It also is seen that the principal payments, *which is all that Bemis provides for,* amount only to (40 x 1.05) = $42 at the end of the 40 years, whereas the interest accumulations *to be obtained from the profits* amount in the 40 years to $58.

By the 5 per cent. sinking fund scheme as last advocated by Bemis, the first payment is only $.83 for each $100, while the fortieth payment calls for $5.565 or $4.735 in addition to the $.83, which $4.735 is the interest accumulation to be met for that year. It is also to be noted that the principal payments, which is all that Bemis provides for, amount only to (40 x .83 =) $33.20 at the end of the 40 years, leaving $66.80 sinking fund interest to be provided from the additional profits from reinvestment.

The importance of this point must not be lost sight of. If the sinking fund plan is to be followed, then the earnings of the sinking fund payments must be allowed to accumulate for the benefit of the depreciation fund, whether these accumulations come from the banker who borrows the money, the securities in which the fund is invested or the segregated earnings from the reinvestment of the fund in the business.

Then it resolves itself into the question: Shall we pay for our depreciation at a uniform rate, year by year, as it occurs, charging up the full amount, found by dividing the cost by the estimated number of years, or shall we lessen the apparent burden for the first years at the expense of the later years?

If there is some case to be met where a certain amount of money must be forthcoming at a certain time, and to this we are pledged, and we can afford to put the money out of our hands, the sinking fund may well be adopted; but, if we require each year for extensions, an amount equal to or greater than the amount required to be set aside to cover depreciation (the latter is almost sure to be the case) then certainly the simpler method and the cheaper is to use this fund for these extensions, letting these additional assets stand against the depreciation of the original assets. In such a case and, in fact, in every case, the yearly depreciation must be computed on the additional assets also.

The sinking fund plan is particularly applicable to munici-

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pal undertakings where there are definite requirements by law as to repayment of loans.

We must bear in mind that if we lay aside the depreciation fund to earn interest, then to a like extent we must borrow other monies in one way or another to meet extensions, so while we are apparently saving on depreciation by reason of the reduced amount required for the depreciation sinking fund, we must pay interest on the like amount borrowed at probably a higher rate of interest for extensions. So, if our books do not show the facts completely, the depreciation charge will be lowered while the interest charge will be increased, both of which conditions will be embarrassing when we have to meet Professor Bemis or his followers who aim to cut down both operating cost and capital return below points practically maintainable.

Coming back to Professor Bemis' Buffalo testimony, we find (page 669) the following attempted explanation of the failure of his 5 cents per thousand allowance to agree with Professor Marks' appraisal of structural value: "I next observed that 5 cents a thousand feet put into a depreciation fund would be about 1 per cent. (it was less than 1 per cent.) on the investment or on the assumed new cost (cost new) as given by Marks, but taking it as 1 per cent. I found that 1 per cent. of the cost of all put into a 5 per cent. sinking fund OR *invested in the plant where it brings in 5 per cent.*, will amount in 20 years to 33 per cent.; in other words, a depreciation of 33 per cent. on the present plant to-day as compared with a new plant means that it has had an average life of 20 years only, or, if you take it on a 4 per cent. sinking fund basis, it only means 21 years life. If the plant has had an average life of 21 years, then it has depreciated 33 per cent. on even 5 cents allowance a year."

From what has just been said it will be seen that the 1 per cent. a year would not have accumulated to 33 per cent. in 20 or 21 years *unless the interest accumulations on the 5 per cent. compound interest basis had also been taken out of the earnings against depreciation,* all as shown by the table above.

It must here be explained that Marks had made his ap-

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praisal of structural value, by taking present cost (or so claiming) and then taking from the total amount to cover depreciation 33⅓ per cent. without regard to age or condition of several parts, including apparatus just purchased. He was not clear as to whether he meant present replacement cost or original cost. In places he claimed to use present prices and, in one case, aimed to back up his assumed present prices of pipe by quoting from an affidavit of our late engineer, Mr. Herron, made about eight years previously, Mr. Herron himself having been dead—which Marks did not know—some two or three years. He also omitted from his schedule parts which he did not find in use, such as the hydraulic drawing machine, which was in the machine shop for repairs.

As a further example, he deliberately and persistently excluded a holder tank in perfect condition, in use as a tar tank, although he went out of his way to praise the ingenuity of the man who had so made it available for effective service in a new line. He seemed to be quite unaware of the fact that this is not an unusual practice in our business.

He included in his general appraisal nothing for working capital and when this was brought to his attention (the error was probably due to an oversight though he would not so acknowledge) he claimed that he had fixed the working capital in his mind at somewhere between $70,000 and $100,000, and concluded that his structural appraisement was sufficiently ample to cover this item also. So *if* this were the fact, he had included $70,000 to $100,000 for working capital, and then depreciated it 33⅓ per cent. with the other items. This is my first experience with an "expert" who would go so far as to first fix on a *net* amount for working capital and then deduct for depreciation.

Let me give a few other examples of Professor Marks' appraisal and estimate on depreciation so that it may better be understood what Professor Bemis had to harmonize his testimony with.

He took 33⅓ per cent. off holder and apparatus foundations, irrespective of whether they were under old or new plant. He testified that he depreciated holders on the score of age, for

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they were ample in capacity. Under cross-examination it was shown that he depreciated the newer holders at the same rate as the old. Under re-direct examination he testified that he did not depreciate each particular holder 33⅓ per cent., but he "lumped" them and specifically stated that a holder built five years ago would not be depreciated as much as one built 40 years ago. When testifying as to the comparatively new Forrest Avenue holder he dodged the question of age, obsolescence and inadequacy, but stated that the holder had a very large depreciation due to decay, and "33⅓ per cent. would not be too much to give it." He finally admitted that it was too dark to examine the holder, it being encased in a corrugated iron house, but that this housing would necessarily damage the enclosed holder because the house would act as a condenser and keep the holder sheets continually moistened. Thus he built up a 33⅓ per cent. depreciation charge on a holder and foundations in perfect condition (the iron house was depreciated) on a theory that was absolutely contradicted by the facts, and he finally had to confess that he had made no examination of this holder because it was too dark.

On the meters in stock he first took off 50 per cent. for special depreciation and then the meter item as a whole was depreciated with the other apparatus 33⅓ per cent. Many of these meters were in perfect repair and practically as good as new.

On cross-examination he was questioned on this point as follows: "And if you take a meter and put it in yesterday, to-day you would value it 33⅓ per cent off? Answer, "Yes." Thus it appears that to this expert it makes no difference whether apparatus is new or old or whether it is kept in repair or left to deteriorate. He depreciated the mains 33⅓ per cent., although in the stipulation the City admitted there was no cause for complaint as to service including pressure. *Hence, the mains were not inadequate, and being cast iron pipes they were not obsolete.* And he himself testified that "cast iron pipe practically, unless in the presence of alkaline or acid earth, takes its coating of rust and then quits and lasts forever, so far as the main is concerned."

"Q. That is in ordinary ground?

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A. In ordinary, good, clean ground.

Q. And if there is not something out of the ordinary here, that will be the life of the plant?

A. Yes."

On page 612, his testimony shows that he had no reason to think the Buffalo pipe is not laid in "ordinary, good, clean ground."

As a general commentary upon his valuation and his estimate of depreciation, Marks admits that his examination was only partial and (page 414) that his figures were only "rough approximations."

Professor Bemis is an extremely adroit and resourceful witness but to support Professor Marks' estimates on structural values and depreciation seemed to be a task beyond even his powers. But he made a plausible effort, for in the quotation last made from Bemis' testimony, he attempts to back up Marks' 33⅓ per cent. depreciation by showing that his 5 cents a thousand allowance for depreciation, equal to about 1 per cent. on Marks' valuation before deducting for depreciation, would in about 20 years amount to about 33 per cent. of that valuation. Thus he attempts to apply an estimate on depreciation for the future to a past period, disregarding all elements of repair and renewal and money put into plant, the fact being that the plant had been to a great extent "restored" about eight years before in connection with consolidations of three companies. Thus Bemis' testimony shows the fallacy of his reasoning as to life of plant, as he makes the life vary with the assumed rate of sinking fund interest—that is, 5 per cent. fund, 20 years life—4 per cent. fund, 21 years life—(actually the sinking fund calculation makes it more than 21 years).

Here it is evident how Bemis as a statistician confuses the variation due to sinking fund provisions for payment with the estimate on average working life which must precede all calculations as to methods of financing and which is not affected in any degree by variation in these methods. This point of average life I shall refer to again.

These gas hearings may well be referred to to make clear another point in connection with estimates on depreciation

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which has to be kept in mind in connection with our accounting and especially when we are under fire. We must remember that in all probability the tribunals before which we must defend ourselves, even though they may be anxious to render a fair judgment, will be handicapped by lack of information on the question at issue and perhaps particularly so as to this question of depreciation which is intricate and, because it has to do with the future, is at the best necessarily a matter for expert judgment and estimate. Hence the way is open for plausible statements and arguments which are far from representing the facts as I have already shown. We must then be prepared to show the fallacies of the testimony brought against us. We must be prepared to find the same witness magnifying the depreciation when estimating the value of plant and minimizing it when attempting to show a low cost for gas at the burner. As an example, in the New York Consolidated Gas case before the Master, Marks testified that no accountant's figures of cost, etc., should be accepted unless the work had been supervised by one skilled in the business. The parties opposed to the Gas Company were assisted by a firm of chartered accountants and their work was checked up, or said to be, by an advisory Board of Engineers, of which Marks was a member and apparently the controlling spirit. This Board recommended a rate to be charged for depreciation in making up cost of gas, which was based upon a single entry for an isolated period and, as such, approved by the Company's Board of Directors. The Advisory Board approved this schedule as generally applicable, on the ground that the Directors had themselves declared the facts.

The lump sum approved as to manufacturing plant on this occasion and for the particular purpose in mind amounted to (.02%) .02 per cent. of the book value—or in other words, *allowed for a life of* 5,000 *years.* On the whole plant .8 per cent. was approved, which allowed for an average life of 125 years. And yet in testifying as to plant values Professor Marks had been quite liberal in his estimates of depreciation.

The point I now wish to cover has to do with the compari-

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son between present values of plant and estimates on depreciation.

In the Holyoke case I was asked a number of questions along this line: If you estimate that a certain piece of apparatus has a life of 50 years, is it not true that it will be worth only 50 per cent. of its original value at the end of 25 years?

In the Buffalo case, Professor Bemis attempted to show by my Holyoke testimony that there must be this proportionate decrease in value although, in that testimony, I had denied the proposition and had clearly shown that such was not necessarily nor probably the case.

The attempt was also made to put my testimony in conflict with that of Mr. A. E. Forstall, who had testified for the Buffalo Company as to structural values.

Mr. Forstall's appraisal was based upon present condition of plant as he found it after painstaking detailed examination.

Such examination at once told him as a qualified expert whether the apparatus was inadequate or obsolete. If not deficient in either of these particulars, then he valued it according to its present structural and working condition. As I understand, he worked upon the theory that inadequacy and obsolescence are the two elements of depreciation most difficult to correctly estimate when looking into the future but, by one properly qualified, easily determined at the time by examination; and when looking at the plant itself to determine present value, if the plant is not obsolete and not inadequate, the problem resolves itself into one of straight appraisal for the duty in hand. As to whether the plant will be obsolete or inadequate 10 or 15 years from then, he is not called upon to determine, though, if making an estimate for the future on depreciation, he would consider these items and make such allowance as his experience seemed to call for under all the conditions to be observed and apprehended.

Let us for a moment consider the three chief elements to be included in forming an estimate as to future depreciation whether on new or old plant. But, first, it should be borne in mind that no matter what estimate or table is made up, the figures should be revised from year to year as we expect to do

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with any estimate extending far into the future. The three elements leading to the loss of value which we rather loosely denominate as depreciation are:

Obsolescence,
Inadequacy,
Physical Decay.

The first may become a very serious item as has been found in the electric lighting business, and its neglect has led and may lead to many passed dividends.

Inadequacy is also important and hard to cover by estimate. Here comes in the question of original lay-out. The plant may have been designed to meet present needs and honestly constructed but manifestly inadequate for any large increase in business. Some inadequacy we are sure to encounter sooner or later unless the plant was originally laid out on a scale not warranted at the outset of the enterprise. We are continually having to meet the question of inadequacy in our distribution systems. While some mains may remain more than ample in capacity, others are found to be inadequate. In other words, the business has developed as a whole and, in some districts, has developed along lines as we did not expect, leaving us with a surplus capacity in directions we had estimated for too liberally. Finally we have physical decay. Unfortunately the layman and some accountants are too apt to think that this last is the only item to be really considered. Here comes in the theory that if you have *assumed* for the future a certain average life of plant, you can carry that estimate back over the past and make it apply to present values of plant by simply determining the expired average life and so establishing a ratio of depreciation to apply to the plant as it at present exists. Nothing could be more fallacious. *If* the depreciation estimate had been the same as that now adopted, it would still remain to analyze its contents and compare item by item with the facts as found by experience and by examination of the plant and accounts. For instance, we might have estimated an average life of 50 years for the mains, taking into account the question especially of inadequacy; but when we come later to apply that estimate to the present condition of plant, we might find that

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the business had not devoloped as had been assumed, that the growth had been along lines not before contemplated and that these districts had been covered by new mains and that the mains as originally laid were still adequate, and being cast iron pipe, well laid, they were not obsolete, and showed practically no physical decay, the condition as to joint leakage, etc., having been maintained by efficient current repairs.

Buffalo furnishes a striking example of elimination of inadequacy as to mains, for the natural gas competition had reduced the output in 1906 to about 636,000,000 cubic feet a year, distributed through 381 miles of main.

Furthermore, any unamended original estimate will be upset by reinvestments of depreciation fund in new plant for extensions; while if depreciation is cared for by sinking fund, the working value of plant is not necessarily the original value minus the estimated depreciation, as that would mean that depreciation is evenly spread and evidenced over all the years of plant's life; if such were the case, there would be no need of any estimates in connection with depreciation.

On the other hand, plant might be found which was in perfect physical condition, but which was greatly reduced in value by reason of obsolescence or inadequacy.

Here is where the appraisal of a plant by a man really expert in the business, expert as a constructor and an operator, comes in to clear up questions *to date*. Such an appraisal can give the actual present value with regard to obsolescence, inadequacy and physical decay. As to the two first elements, the expert can, through the exercise of his trained judgment, in connection with a study of the plant and the business, arrive at the truth. As to the last element he may not be able to see all working and hidden parts but, by a thorough examination of the plant supplemented by a close scrutiny of the methods followed in operation, including repairs and current renewals, he can very closely appraise the value as to this element.

Having disposed of the elements of obsolescence and inadequacy, a man really expert as a constructor and operator may well discover that certain of the parts of plant, although erected some years before, are as good as new and, in some special

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cases, he may find parts which he would prefer to the equivalent apparatus then purchaseable. And still there is absolutely nothing in this statement in opposition to the proposition that provision should be made for equalizing, as far as possible, the cost of depreciation over all the years involved. Anything like a full comprehension of this important and puzzling subject must at once convince that, for its solution, is required not only the best efforts of the thoroughly competent constructing and operating engineer and manager, but also the best efforts of the thoroughly competent accountant.

I have a great respect for the work done by many of the British chartered accountants and I think that we in the United States are to be congratulated that some of their ideals and methods are being imported for our benefit. We are also to be congratulated on the independent work being done by our own accountants. The security of our industrial undertakings is distinctly enhanced by the intelligent painstaking efforts of these men to develop systems of accounting which will give the whole truth. I hope the day is approaching when in the United States the services of the best of these men will be still better appreciated.

Ever since I have given special attention to this subject I have been interested in all that I could read on depreciation from the pens of British chartered accountants. Deservedly prominent among these men is chartered accountant—now professor—Lawrence R. Dicksee. In the April 16, 1907, issue of the *Journal of Gas Lighting* appears an abstract of a lecture delivered by him before the Chartered Accountant Students' Society on "Depreciation, With Special Reference to the Accounts of Local Authorities." Part of this lecture might very well receive the careful attention of those engaged in making comparisons between private and municipal control of public utilities. For instance, quoting from the abstract:

"At the outset the lecturer directed the attention of his audience to the importance attaching to the subject, because while on the one hand, the finances of local authorities are asserted to be in an 'absolutely rotten' condition, it is urged that so long as the authorities comply with their statutory requirements, and

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set aside annually out of their revenue a certain amount to form a sinking fund to provide for the eventual repayment of their loan capital, they have done all that is necessary, and even more than is attempted in most proprietary businesses."

Again—"At the same time, by definitely ear-marking from year to year gross profits which in all fairness ought to be set aside to provide for future expenditures, it becomes possible to provide reasonable reserve for contingencies, thus avoiding the fatal policy of reducing prices to a level which it will be impossible to maintain in future years, when heavy expenditure for renewals has to be provided out of revenue because no borrowing power can be obtained."

As I wish particularly to bring to your attention a table introduced by Professor Dicksee, let me quote a few short passages to put you in touch with his line of thought.

Quoting again from the abstract:

"He then proceeded to consider his subject, and began by explaining the term 'depreciation' as meaning the loss or shrinkage in value that inevitably occurs from time to time in the assets which represent the capital equipment of a business, as a result of their employment therein; this loss being attributable to wear and tear, lapse of time, the march of modern invention, or to any or all of these causes combined. He pointed out that this shrinkage in value must be looked upon as a working expense of the business, in just the same way that the hire of assets would have to be regarded if the use of them had merely been acquired for short periods, instead of capital having been expended in the acquisition of them." * * *

"So that, at all events, by the time an asset is discarded, a sum equal to its original cost, or the cost of replacing it by another asset equally efficient, shall be charged against revenue, and thus the proper charge shall be borne by the revenues of a series of years, even though there may be inequalities in the apportionment of the charge as between one year and another in the series."

After discussing depreciation in connection with the issue of loans by a local Government Board he points out: "From these particulars, it will be seen that the average effective life

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(estimated working life less residual life) of the undertaking as a whole works out as nearly as possible 48¾ years; and upon this basis a loan would in all probability be granted for 48 years, or thereabouts. But, upon comparing the loan period with the column showing the effective life of each class of asset, it will be found that in no single instance do the two correspond. In some cases the working life is very considerably greater, while in others it is very considerably less; and in no single instance is it even approximately the same."

Before passing on to the Dicksee life table, let me call attention to another article on depreciation as it appears in the April 23d, 1907, issue of the *Journal of Gas Lighting*, being an abstract of a paper read before the Institute of Directors by Chartered Accountant P. D. Leake.

He defines "depreciation" as "expired outlay on productive plant" and productive plant as "all perishable material property owned by an undertaking other than that primarily intended for sale."

"The factor of depreciation constitutes a very large part of the operating expense of most industrial undertakings; and the hopeless state of chaos into which it has drifted constitutes a grave public danger, which is even assuming the dimensions of a national danger in these days of municipal enterprises."

This last quotation confirms what we all have suspected and many of us have known, namely, that the truth as to municipal trading in Great Britain does not lie upon the surface.

In the following table I first reproduce the figures exactly as they appear in the Dicksee article; then I add a column to show how the author arrives at his "average life" of 48¾ years; then I add two tables of my own based upon the data supplied by Dicksee's table, in which I give the true average life and the number of years required for a certain annuity to accumulate to an amount equal to the first cost of plant provided no withdrawals are made. This last is not a true average life, as will be explained.

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"Average Life" Table from Prof. Lawrence R. Dicksee's article as abstracted in London Journal of Gas Lighting, April 16, 1907, with additions and modifications by Alex. C. Humphreys, based upon Dicksee's assumed data.

Class of Asset.	Dicksee's Table. Estimated Life Years.	Residual Value Per Cent.	Effective Life Years.	Am'nt of Expenditure Per Cent.	A. C. H.'s Proof of Dicksee's Computation of "Average Life."	Modified Tables by A. C. Humphreys. For Reinvestment in Plant. No Interest. Number of Times each Class of Asset Renewed. in 100 yrs	Total Renewal Expenditure in 100 yrs. — Per Cent.	Am't-yrs. Effective Life Multipl'd by Total Renewal Exp'd't're	For 3½% Sinking Fund. Required to Redeem 100 at End of Years Given.	Amount required each year to redeem 100 worth of mixed assets.
Land,	100	.	100	4.00	.04 x100 = 4.0000	1.	4.00	400.00	.11593	.0011593x 4.=.0046372
Buildings,	80	..	80	14.00	.14 x 80 =11.2000	1.25	17.50	1400.00	.23849	.0023849x14.=.0333886
Foundations,..	100	..	100	10.00	.10 x100 =10.0000	1.	10.00	1000.00	.11593	.0011593x10.=.0115930
Boilers, .	25	5	26.3	5 50	.055 x26.3= 1.4465	3.80	20.90	549.67	2.379	.02379x 5.50=.1308450
Dynamos,.	30	8	*32.3	6.00	.06 x32.3= 1.9380	3.10	18.60	600.78	1.717	.01717x 6. =.1030200
Engines and machinery,	25	6	26.6	21.50	.215 x26.6= 5.7190	3.76	80.84	2150.34	2.338	.02338x21.50=.5026700
Cables, .	35	15	41.2	32.00	.32 x41.2=13.1840	2.43	77.76	3203.71	1.120	.01120x32 00=.3584000
Arc lamps,	12	5	12 6	1.20	.012 x12.6= .1512	7.94	9.53	120.08	6.451	.06451x 1.20=.0774120
Arc lamp posts,.	40	5	42.1	1.00	.01 x42 1= .4210	2.37	2.37	99.78	1.075	.01075x 1.00=.0107500
Accumulators,...	15	10	16.6	.20	.002 x16.6= .0332	6.02	1.20	19.92	4.545	.04545x .20=.0090900
Motors, .	25	9	27.5	.55	.0055x27 5= .1512	3.64	2.00	55.00	2.222	.02222x .55= 0122210
Office Furniture,.	15	5	*15.5	.30	.003 x15.5= .0465	6.45	1.94	30.07	4.969	.04969x .30=.0149070
Meters,	12	2	*12.3	3.40	.034 x12.3= .4182	8.13	27.64	339.97	6.645	.06645x 3.40=.2259300
Accessories and instruments,.	12	2	*12.3	.15	.0015x12.3= .0185	8.13	1.22	15 01	6.645	.06645x .15=.0099675
Tools, &c.,	10	5	10.5	.20	.002 x10.5= .0210	9.52	1.90	19.95	8.045	.08045x .20=.0160900
			100.		"Average Life" =48.7483		277.40	10004.28		1.5209213

"Average Life" as computed by Prof. Dicksee from his assumed data, 48¾ years. *If Prof Dicksee's method of computing "Effective Life Years" is understood it seems that the figures "starred" should be respectively 32.6, 15.8, 12.2, 12.2.

Dividing the total of "amount years" by Total renewal expenditures in 100 years (10004.28 ÷ 277.4) we find the true average life to be 36.06 years.

Say 1.52% which on a 3½% Sinking Fund represents an "average life," or more correctly, an average redemption period, of 34¾ years instead of 48¾ years.

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From Professor Dicksee's paper, it would appear that the method generally followed in Great Britain in averaging the life of plant in connection with depreciation is that employed in the table here reproduced. It is particularly to be noted that the author himself points out how the "average life" thus found *fails to provide for the renewal of the several classes of assets as their individual life periods expire.* This should at once be convincing that the "average life" so obtained is not safely to be employed. A study of the complete table will show that the methods followed in my two modifications of the Dicksee table do give averages which provide for the renewal of each class of asset as its individual life period expires, whether the method of financing the depreciation loss be by the sinking fund or direct reinvestment in plant extensions; and that in both cases the withdrawals, necessarily required by the assumed terms of the life table, do not interfere with the scheme as a whole. The reason for this difference is that in my table the case of each class of asset is considered by itself and the total yearly requirement is the sum of the separate requirements.

This will perhaps be made still plainer in some tables which follow.

It is evident to any practical man who has really studied the subject of depreciation that no general rules can be followed in the preparation of a depreciation life table for, necessarily, this is in each case a matter of estimate based upon an expert consideration of present conditions as to character and condition of plant and future conditions as to care of plant, methods of accounting, changes in the art and growth of the business; and as to the future, in addition to probable physical deterioration, as before said, we must particularly consider the probable effects of obsolescence and inadequacy. Furthermore, the table as originally made up should be modified and corrected as conditions demand from year to year.

These being the facts, it is all the more important that the life table as mathematically developed should correctly represent the assumptions included in the general life estimates, and

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that we should not add to our difficulties by introducing errors of theory.

In the life table just given, I have shown that the so-called average life as given in Professor Dicksee's article, and as frequently employed in accounting practice, does not give a true average life. The fact is that no sinking fund scheme gives a true average life, *although if correctly computed,* the so-called average life closely corresponds to the true average life. In what follows I wish it to be understood that, when I say true average life, I mean correctly computed on the assumptions made—I do not mean that the average life as so computed is in any case more than an estimate based upon expert knowledge and experience.

The differences as to what may be considered the average life of a plant, as exemplified in my analysis of the Dicksee Table, are of such vital importance to an understanding of this subject that I shall venture to quote at length from the Supplement of my Lecture Notes on the Business Features of Engineering as used with my classes at Stevens Institute of Technology. This particular point so repeatedly puzzled the members of my classes that I wrote this supplement in the effort to clear up the difficulties experienced, which is practically as follows:

SUPPLEMENTAL NOTE ON DEPRECIATION.

April 15, 1905.

On page 117 of "Lecture Notes on Some of the Business Features of Engineering Practice" appears the following:

"It is well here to draw attention to a mistake which is sometimes made in estimating the average life of a plant. Take the case we have already considered and the calculation might be as follows:

Part of Plant.	Years.		Value of Parts in Dollars.		
A	10	x	25,000	=	250,000
B	15	x	50,000	=	750,000
C	25	x	100,000	=	2,500,000
D	35	x	150,000	=	5,250,000
E	50	x	175,000	=	8,750,000
			500,000		17,500,000

17,500,000 ÷ 500,000 = 35 years average life."

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(If the average life of the plant were as long as 35 years we find by referring to the annuity table that it would require only 1.358 per cent. of the total value of the plant, that is, $6,790, set aside each year at 4 per cent. compound interest to rebuild the plant as a whole at the end of the 35 years of life.)

I then show, step by step, that $6,790, the amount that would be sufficient under a 4 per cent. compound interest sinking fund plan to redeem $500,000 in 35 years, if left undisturbed, would not be sufficient to provide for the renewals of the several parts of plant in accordance with the assumed life table.

Although this part of the subject was so covered at considerable length, I now find that it is advisable to go farther, and especially to answer two questions which have been asked.

Some say: "Why should anyone expect such a calculation to give the average life?"

Others say: "While it is apparent that this process does not give the correct result, why does it not do so?"

As to the first question, I can only suggest that those who have fallen into the error have done so by confusing this case with other cases not so complex.

For instance, if we had 25,000 castings weighing 10 pounds each, 50,000 castings weighing 15 pounds each, 100,000 castings weighing 25 pounds each, etc., we could find the average weight of the 500,000 pieces by the process shown on page 117. Or, if we had 25,000 yards of cloth costing 10 cents a yard, 50,000 yards costing 15 cents a yard, 100,000 yards costing 25 cents a yard, etc., we could find the average cost per yard by the same process.

This answer replies to the first question, but makes the difficulty of those asking the second question all the greater; they now say, "If this calculation is correct in the case of averaging weights, costs etc., why is it not correct for averaging the life of a plant?"

The reply is that the process would be correct if it covered all the elements of the proposition and was correctly applied.

To better follow the several points involved, let us consider

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this process of averaging in the case of a plan for meeting depreciation *without the aid of interest accumulation.* In this case, if certain parts of the plant valued at $25,000 are to be renewed in ten years, then each year we must lay aside to meet the depreciation of these parts 1-10th of $25,000. And so we would require 1-15th of $50,000, 1-25th of $100,000, etc. The total amount required each year would then be $17,619, derived as follows:

1/10th of	25,000 =	2,500
1/15th "	50,000 =	3,333-1/3
1/25th "	100,000 =	4,000
1/35th "	150,000 =	4,285-5/7
1/50th "	175,000 =	3,500
	500,000	17,619

But if the correct average life were 35 years, the total amount required each year would then be (omitting interest, remember) $500,000 \div 35 = \$14,285.71$.

Now let us see why 35 years, and $14,285.71, derived therefrom, are not correct.

If we are to find the average life of the plant, we must state our proposition so as to include all the dollars involved in the full fifty years period. For instance, during the fifty years we have to take care of Parts "A," $25,000, five times, for these parts have to be renewed every ten years. So for all parts we shall have to consider the number of times they will have to be renewed during the fifty years period.

Bearing this point in mind, the proposition stated on page 117 of the Notes will then take this form:

TABLE "A".

1	2	3	4	5	6
Part of Plant.	Years.	Value of Parts in Dollars.	Times renewed in 50 years period.	Total Requirement in 50 years Period.	DOLLAR-Y'RS. Being am'ts in Column 2 multiplied by amounts in Column 5.
A	10	25,000	5	125,000	1,250,000
B	15	50,000	3-1/3	166,666-2/3	2,500,000
C	25	100,000	2	200,000	5,000,000
D	35	150,000	1-3/7	214,285-5/7	7,500,000
E	50	175,000	1	175,000	8,750,000
		500,000		880,952	25,000.000

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In explanation of above table it is seen that having calculated the total number of dollars required during the 50 years for each class of plant, we then, in each case, multiply by the number of years during which each dollar (or the plant which the dollar pays for) does duty. Thus we obtain the results shown in column No. 6, namely, the "dollar-years."

Dividing now the total dollar-years by the total dollars to be provided during the 50 years, we have 25,000,000 ÷ 880,952 = 28.3783 years as the true average life of the plant represented originally by $500,000.

If our result is correct, the amount required each year to cover depreciation (omitting interest) should be the total number of dollars to be supplied during the fifty years divided by 50—that is, 880,952.38 ÷ 50 = $17,619; and it should also be the original value of plant divided by 28.3783, the average life of plant; that is, 500,000 ÷ 28.3783 = $17,619. And, without considering the question of average life, we have already found that to replace *each year* 1-10th of $25,000, 1-15th of $50,000, 1-25th of $100,000, 1-35th of $150,000, and 1-50th of $175,000 requires $17,619.

So we find that if the process *indicated* on page 117 is correctly stated, performed and applied, we get a true average life of 28.3783 years, requiring an annual payment from profits of $17,619 to provide for depreciation without interest accumulations.

To guard against possible misconception as to the so-called average life of plant in connection with the Sinking Fund method of providing for depreciation, we may well consider in a little more detail the difference in this respect between the compound interest sinking fund process and the direct method in which is set aside each year the actual amount of estimated depreciation.

In the case we have been considering—referring to page 116 of the "Notes" and Table "B" to follow—we find that the amount required to care for depreciation of the $500,000 by the 4 per cent. compound interest sinking fund scheme is $10,-163.50, which is 2.03 per cent. of the $500,000; and this 2.03 is almost exactly the per cent. required to redeem the *total origi-*

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nal cost of the plant in 27¾ years, *provided the sinking fund is not disturbed* (in the original "Notes" I say about 28 years, but 27¾ years is more exact); and furthermore this per cent. is sufficient to pay for the recurring renewals of the several parts "A," "B," "C," "D" and "E," in accordance with the life table assumed.

But we have seen by the calculations made in these supplementary notes that, by the direct method of setting aside each year the actual amount of depreciation, the true average life is 28.3783 years. In this particular case, these two figures, 27¾ and 28.3783, are so nearly the same that one might be led to suppose that they should be in actual agreement, and that the difference is due to lack of exactness in the compound interest calculations. A little thought will show that an agreement should not here be looked for.

In the direct method we are arriving at a true average life —that is, the "average life" is the *number of years elapsed when the plant will have depreciated an amount equal to the first cost,* and hence, necessarily, the number of years when the accumulated payments to cover depreciation will have amounted to the first cost of plant.

Whereas, in the compound interest sinking fund scheme, the average life (if we permit ourselves to use this term) simply means the number of years required for a certain annuity to accumulate to an amount equal to the first cost of plant, *provided no withdrawals are made;* the amount of this annuity with its interest accumulations being such, however, that when, from time to time, it becomes necessary to make withdrawals to cover depreciation in accordance with the provisions of the scheme, there will always be found in the fund a sum sufficient to meet these recurring demands.

By the direct scheme (no interest) the accumulation of annual payments in the fund must necessarily be equal at the end of any year to the accrued depreciation. By the compound interest scheme this necessarily would never be the case unless a time was reached when all the parts of plant expired at the same time.

For instance, in the life table now under consideration, there

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is always an overlapping of the life periods of the several parts of the plant, and so there will never be in the fund sufficient to meet the total *accrued* depreciation, though *there will always be enough to meet the requirements as to each part of the plant as it has to be renewed.* This means that when this overlapping of life period occurs, as it probably always would in practice, the compound interest sinking fund scheme, strictly speaking, is only applicable to the case of a plant operating in perpetuity.

To illustrate:

On pages 122 and 123 of the "Notes" it is shown that by the sinking fund scheme we should have in the sinking fund at the end of the fifty years, after making all payments required for the renewals of parts "A," "B," "C," "D" and "E," $54,-195. The calculations are then made to show what should be the accrued *sinking fund liability* on account of the depreciation of parts "B" and "D," the only parts the lives of which overlap the 50 years included in the table. It is shown that the five years' sinking fund liability on parts "B" and 15 years on parts "D" will amount to $54,312, being practically in agreement with the balance shown in the fund.

But this is *not* the actual accrued liability for *depreciation,* at the end of 50 years, which would amount to

"B" – 15 years life, $50,000; 5 years accrued,

$50,000 x 1/3 = $16,666.66

"D" – 35 years life, $150,000; 15 years accrued,

$150,000 x 3/7 = 64,285.71

$80,952.37

It is thus seen that the compound interest sinking fund scheme, and the simpler scheme, which eliminates interest accumulations, are essentially different in operation. In connection with the sinking fund scheme the term "average life" is misleading, whereas, by the direct scheme the true average life, if desired, can be determined by the method shown in this supplementary note.

To further illustrate that the true average life (as far as it can be true, based upon estimate) will not be the same as the time during which a sinking fund scheme, if undisturbed,

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will accumulate the total value of plant, we may add a 2 per cent. and a 6 per cent. sinking fund scheme to the life table already used. To make the comparison more apparent, I will include in the one table these two schemes, the original 4 per cent. scheme and the direct scheme which entirely eliminates interest:

TABLE "B."

Parts of Plant.	Estima Life in Years.	Value of Plant in Dollars.	Amount to be set aside each year to cover depreciation. 6% Sinking Fund.	4% Sinking Fund.	2% Sinking Fund.	0% No Interest.
A	10	$25,000	1896.75	2082.25	2283.25	2500.00
B	15	50,000	2148.00	2497.00	2891.50	3333.33
C	25	100,000	1823.00	2401.00	3122.00	4000.00
D	35	150,000	1345.50	2037.00	3000.00	4285.71
E	50	175,000	602.00	1146.25	2068.50	3500.00
Total value of Plant and total annual payments		500,000	7815.25	10163.50	13365.25	17619.04
Annual payments in % of Plant value			1.563	2.03	2.673	3.524
Years Required to Redeem total value of Plant			27.05	27.73	28.2	28.378

It is thus seen that as the interest rate of the sinking fund increases not only will the annual depreciation payment be reduced in amount but, if we stipulate that in the meantime no withdrawals shall be made as in fact called for by the life table, then the time required to accumulate the total value of plant will also be reduced.

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This seeming contradiction is the result of this stipulation, necessarily introduced for this time comparison. For we must remember that the amounts actually withdrawn to meet partial depreciations ("A," "B," "C," "D" and "E"), in accord with the life table, will be the same, no matter what the sinking fund rate of interest; and as we assume that these amounts are to be left in the fund and allowed to accumulate, the higher the rate of sinking fund interest the greater will be the tendency of these accumulations to reduce the time in which the total value of plant will be produced.

It is true that there is another factor involved in this comparison of so called average lives, though no reference to it is apparently called for by the comparative figures above given. So where the factor just explained tends to shorten the so-called average life, this second factor here tends in a minor degree to lengthen it.

That is, the higher the sinking fund rate of interest, the smaller will be the *sinking fund* liability for each part between the several withdrawal dates; therefore, the slower the accumulation and a consequent tendency between withdrawal dates to lengthen the so-called average life. While this tendency ceases for each part at its withdrawal date, the tendency is always in force with some of the parts, and therefore always affects the scheme as a whole.

I may avail myself of this opportunity to answer another question which seems to have puzzled a number of the class: "Why complicate the problem of depreciation with questions of compound interest; why not each year take out of profits for plant which will have to be renewed in ten years, 1-10th of its cost, for plant which will have to be renewed in 15 years, 1-15th of its cost, etc., and then let the interest on the depreciation fund be absorbed year by year into the profits?"

This is exactly the case I have covered in the sixth paragraph, page 129, beginning:

"The simpler and more usual arrangement."

I also refer to this plan on pages 138 and 139.

The objection is the larger amount required in the first instance to cover the annual depreciation charges.

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We have seen that by the more direct method it would require $17,619 a year taken out of profits, whereas by the 4 per cent. sinking fund scheme it would require only $10,163.50; that is, 3.524 per cent. of the cost of plant instead of 2.03 per cent. of cost.

This difference might prohibit the adoption of the simpler plan, especially in the early days of a new venture.

I am chiefly concerned to convince you that depreciation should be provided for out of profits, and I have therefore shown the necessity of accurately estimating the depreciation and the manner in which the means may be provided for meeting the item of loss with the least burden to the business.

Let me also emphasize the point that *if* a certain portion of the profits are, year by year, invested in plant extensions to cover depreciation, we must be careful to keep our accounts so that there will be no excuse offered for issuing additional bonds or capital stock against these additions to plant, for by this method we have simply made good the depreciation of certain parts of plant by adding other parts.

(End of Quotation from Supplemental Note on Depreciation.)

As far as gas companies' practice is concerned, too much stress has been laid upon the sinking fund method of financing depreciation. I confess that I may have erred in this direction. In my address as president of the American Gas Light Association (1899), I laid particular stress upon the necessity for some systematic provision being made to meet depreciation and I then discussed the sinking fund method. I was partly led to this by the desire to interest those who might look upon the full burden as too heavy to be at once assumed. But in this case, as in every other in which I have written or spoken on this subject, I have never neglected to point out that, if the depreciation fund were reinvested in plant extensions, *the interest on these investments by one means or another must be added to the depreciation fund, so showing that the sinking fund payment was not the full cost of depreciation.* In my earlier efforts to arouse interest in this subject, I was more interested in the practical and engineering features of the problem and not so much in the accounting feature. I was then

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satisfied to state what I considered the principles which govern rather than to lay stress upon the details of accounting.

The table which I have here given (page 325) in connection with my discussion of Professor Bemis' methods of computation shows clearly the effect of following the sinking fund method rather than the simpler and more straightforward method of setting aside each year for reinvestment the full amount of loss due to depreciation.

In my lectures to the students at Stevens, I am instructing those who will in the future be interested in various lines of work and therefore should be instructed as to the working of a sinking fund. Naturally, then, I lay stress in my instructions upon the more complicated methods of the sinking fund simply because, by reason of the greater complications, the subject is harder to understand.

Attempts have been made to cover the subject of depreciation by tables showing the length of life for each class of plant. It is true that in some cases in connection with these tables warnings have been given to the effect that such tables are only of general value and should not be blindly accepted without regard to local conditions. Such tables are no doubt of some value when used by those competent to form independent judgments. I purposely omit all such data from this paper for fear it may be claimed that I have stated that all brick buildings have a life of so many years, all wood buildings a life of so many years, all holders a life of so many years, etc. That this fear is warranted is shown by Professor Bemis' use of my Holyoke testimony in spite of the fact that I repeatedly stated that my figures could not be used in any general way but had been adopted for Holyoke and Holyoke only after a careful study of Holyoke conditions from the standpoint of the engineer, the manager and the accountant.

Arguments as to the cost of depreciation have also been based upon comparisons of costs per thousand of repairs and current renewals. As I have repeatedly stated, the cost of depreciation must be considered in connection with the declared cost of these items, but here any fair comparison cannot be made unless we have analyzed the character of the work per-

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formed and the methods of accounting followed in each case.

Let me summarize some of the figures tabulated by me in connection with recent cases in which I have been concerned.

In the case of nine Massachusetts companies brought into one case, the repairs and current renewals for the year ending June 30, 1905, were as follows in cents per thousand respectively: 15.17, 10.32, 8.62, 26.73, 12.64, 22.11, 9.16, 6.88, and 15.10. In addition certain amounts had been written off for depreciation which brought the totals to the following: From 15.17 to 22.68, from 10.32 to 14.61, from 8.62 to 15.28, from 26.73 to 31.58, from 12.64 to 57.00, from 22.11 to 66.47, from 9.16 to 26.11, from 6.88 to 22.04, from 15.10 to 21.2. In one case, the second named, there had been also written off for reserve 2.39, bringing the total up to 17.

In the case of 7 Massachusetts Companies, year ending June 30, 1906, the costs per thousand for repairs were found to be respectively: 18.58, 13.54, 12.68, 6.37, 10.19, 14.76 and 15.36.

Adding for depreciation charged up these costs were raised to: 22.85, 13.54 (no change), 18.19, 12.92, 15.90, 14.76 (no change) and 15.36 (no change).

These figures had to be obtained by an analysis of the companies' returns filed with the Commission as they could not be obtained from the published report of the Commission.

After making allowance for differences in physical conditions, these figures show by their wide variation that, in spite of the uniformity as to blank forms used and instructions given, the accounts were not kept along uniform lines.

The following figures show the cost of wear and tear, manufacturing and distribution plus meter repairs, but not including stove repairs, for the London Companies for 1904, as taken from Field's. Analysis converted into United States cents by taking the English penny at 2.02 cents.

Gas Light & Coke Company 11.88c., Commercial 14.22c., South Metropolitan 14.27c., average 3 companies, 12.87c., average of 12 suburban companies 15.15c., combined average metropolitan and suburban companies 13.33c.

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For the year 1905 these figures were found to be 12.10, 13.96, 12.08, 12.27, 15.85 and 13.02 respectively.

Here less difference is to be found as the accounts of the London companies are more nearly, though not by any means absolutely, uniform.

Studying the returns of the 113 British companies covered by the "Gas World" analysis of accounts of Gas Undertakings for the year 1904-5, we find the maintenance of pipes, works and meters in cents per thousand (converted as before) to range from 4.28 to 25.55. There is one lower, namely, 1.92 for Wallasey District Council, but that does not cover maintenance of pipes or meters. The 4.28 is given for Macclesfield Corporation, the Wigan Corporation being almost as low, namely 4.34. Our municipal ownership friends would point to these and other figures in this table as showing the comparatively economical management of the municipally controlled works. Expert analysis would unquestionably demonstrate that the plants had not been properly maintained or the charges therefor had not been properly classified, or both.

For our present purpose it is sufficient to note that no comparison of costs of maintenance of any value can be made on the face of the returns.

There is a natural variation from year to year in the cost of repairs and current renewals and it would be a gain if this cost could be equalized over all years concerned; in other words, if we could have one scheme for so equalizing repairs, current renewals and final renewals; but at present it looks to me as if the additional complications would not compensate for the possible gain to be made.

Before closing let me say a word as to the necessity of creating a reserve, over and above depreciation reserve, to cover the fluctuations in prices of materials and labor, extra hazards of the business, contingencies which cannot be estimated on, such as electrolysis, etc. I think that gas companies should be permitted to build up a reserve fund for this purpose amounting to say 10 per cent. of their investment. I am strongly of the opinion that this reserve, by reason of its very nature, should not in any way be mixed up with the subject of deprecia-

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tion; it is because it has been so treated in some notable cases that I here refer to the subject. The amount per thousand of this reserve should not be included as part of the cost, but should appear as a separate item in the accounts of such years as it has to be withdrawn from the income.

Let me bring this much extended paper to a close by summarizing some of the more important features to be considered in connection with this all-important subject of depreciation.

First, let it never be forgotten that any life table employed must of necessity be based upon estimate.

That being the case, the life table should be corrected and amended from year to year as required by changes in limiting conditions.

The estimate on each life period must be based upon consideration of probabilities as to obsolescence, inadequacy and physical decay.

The probable amount of physical decay will depend upon original design and construction and methods pursued as to maintenance.

In the life table each class of asset must be treated by itself and each class of asset must be provided for as to renewal and each repeated renewal within the period set by the longest life included in the table.

The cost of depreciation must not be confused with figures obtained by considering the financial methods to be employed in caring for depreciation. In any case the annual loss will be the total cost divided by the net total effective years of service.

If the loss is covered by a sinking fund, then the interest accumulations must be recognized as part of the cost, as shown by the table herein—"Result of Company Operating Its Own Sinking Fund." (page 325.)

In considering and comparing costs per thousand of depreciation, the accounting methods pursued must be analyzed and applied.

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Even when comparing given costs per thousand in the case of undertakings employing a uniform system of accounts, variations, avoidable and unavoidable, in applying the system will tend to affect the accuracy of the comparison.

The cost of repairs and current renewals must be taken into account in considering the cost of depreciation and, all other things being equal, the more complete the former the less costly the latter.

In conclusion let me recommend that the whole question of uniformity of accounts, including and emphasizing this most important subject of depreciation, be referred to a committee and that this committee be requested to confer with other representative bodies engaged in the same line of work.

After reading the paper,

DR. HUMPHREYS said: Mr. Chairman, I want to add one word to my paper. I had intended to recommend that the subject of depreciation and uniform accounting be referred to a special committee. I presume that is hardly now in order. I suppose in view of the action that was taken by the Institute this morning in amending the Constitution such matters will be referred to one of the two Standing Committees.

THE PRESIDENT: Before taking up the discussion of Dr. Humphreys' paper we will receive a communication from Mr. Gardiner.

MR. W. H. GARDINER: Mr. President and Gentlemen: This is a communication to the American Gas Institute from the New England Association of Gas Engineers, by the latter's committee, on "Uniform Accounting and Depreciation."

COMMUNICATION TO THE AMERICAN GAS INSTITUTE FROM THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS BY THE LATTER'S COMMITTEE ON UNIFORM ACCOUNTING AND DEPRECIATION.

At the 37th Annual Meeting of the New England Association of Gas Engineers held in Boston on February 20th and entitled "The Present and Growing Need for the General

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Adoption of a Uniform System of Records and Accounts," which, because of its frank and able treatment of the situation, was immediately recognized throughout the country as a most valuable contribution.

Pursuant to a suggestion embodied in this paper and to a motion passed by the New England Association its President appointed a committee of three to consider the matters of uniform accounting and depreciation and to bring these to the attention of the American Gas Institute.

Therefore this committee does hereby respectfully bring the questions of Uniform Accounting and of Depreciation to the attention of the American Gas Institute.

In doing so we would say that pending such action as the American Gas Institute may take on these questions, we have not as yet undertaken any definite work. And yet we have given close attention to the situation as it exists to-day.

On the one hand we note with concern the enactment of commission laws in several new States, which authorize the supervising commissions to put in effect some system or systems of uniform accounting, and we expect wider action along these lines in the near future.

We say we note this movement with concern, not at all because we might not be in sympathy with it, but solely because our researches to date have failed to reveal any system or systems of uniform accounting which would seem to be of that degree of comprehensiveness, flexibility and excellence which would warrant their definite adoption as State or National systems of uniform accounting.

On the other hand, we note with appreciation the close consideration which the subject of uniform accounting is receiving generally, and in particular by such bodies as the American Street & Interurban Railway Association and the National Electric Light Association.

At the last convention of the latter Association a preliminary report on Uniform Accounting was submitted. During its discussion, the expediency and desirability of co-operating with the accounting committees of other associations was expressed.

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The sentiments thus expressed by the electric light accountants were reiterated by members of the Traction and of the Gas Accounting Committees who were present and who took part in the discussion.

Therefore we trust that a motion will be made and will prevail, authorizing the incoming President of the American Gas Institute to forthwith appoint a committee of seven on Uniform Accounting and Depreciation, said committee to be authorized to confer and co-operate with similar committees of other bodies.

Respectfully submitted,

W. H. GARDINER, *Chairman,*
EDMUND CATHELS,
J. J. HUMPHREYS.

MR. GARDINER: I do not know whether that last suggestion is in order in view of the change in the Constitution or not.

THE PRESIDENT: It is entirely in order to make a resolution that the matter be referred to a committee, or that any matter be referred to a committee, but under the Constitution it would not be named by the Chair. The Public Relations Committee has to decide this.

MR. H. L. DOHERTY: Do I understand that the Chair rules that the appointment of a special committee on this is out of order?

THE PRESIDENT: No, sir, I do not rule that a special committee is out of order. The Chair ruled that it wouid be referred to the Committee on Public Relations and that the special committee, if one is appointed, will not be appointed by the Chair.

MR. DOHERTY: I want to recommend that a committee of seven on Uniform Accounting and Depreciation be appointed, with the idea that by appointing a committee of seven perhaps the committee can be divided into two divisions. I move that the new committee on Public Relations be instructed to appoint that committee.

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MR. PAUL THOMPSON: I wish to ask, in view of the appointment of the Public Relations Committee, and the reference to it of all papers, whether it is not for that Committee to decide as to the advisability of appointing a sub-committee to consider any paper referred to it, and that this body can only suggest to the Public Relations Committee the advisability of such an appointment.

THE PRESIDENT: Mr. Thompson, the Chair has ruled that it is entirely proper for the Institute to recommend to the Public Relations Committee that it appoint a sub-committee to carry on any work this Institute may desire. Is Mr. Doherty's motion seconded?

Motion seconded.

A MEMBER: What was the motion of Mr. Doherty?

MR. DOHERTY: My motion was, or my recommendation was, I understand the motion was ruled out, that a committee of seven be appointed to consider this matter in the interim and report on the subject of uniform accounting and depreciation.

THE PRESIDENT: Gentlemen, you have heard the motion. Are you ready for the question? Those in favor will say "Aye," contrary minds "No." Carried.

Pending the submission of this matter to a committee it is proper if anybody in the Institute desires, to discuss the question; to discuss the paper as read.

DISCUSSION

OF DR. HUMPHREYS' PAPER ON DEPRECIATION.

MR. A. S. MILLER: Suppose a company sets aside a sum every year to cover depreciation and puts that sum into extensions. If at the end of a term of years it becomes necessary to replace a holder or building, would a commission grant permission to the company to issue bonds for the purpose?

THE PRESIDENT: You ask would the commission do that?

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MR. MILLER: Yes, would such permission be granted? It would seem prudent for a company to issue bonds or stock for its improvements from time to time, keeping such bonds or stock in its treasury to be sold from time to time when necessary to reimburse the depreciation fund for the sums used for extensions and improvements. If the depreciation fund is used for improvements, and securities issued to reimburse the fund when repairs or replacements become necessary, the claim might be made that the company is issuing stock or bonds for the purpose of making replacements.

THE PRESIDENT: Mr. Carter.

MR. R. A. CARTER: Mr. Chairman, replying to Mr. Miller's question, as I am from a state that has a public service commission, I will venture this opinion: That in the event of his employing his reserve fund for the purpose of making additions to his plant, and the renewal or replacement for which the fund was designed becoming necessary, his application to the commission would be not for consent to raise funds to pay for replacement of plant, but to pay for the new plant he had acquired, and the funds so raised would restore to the treasury the reserve fund which had been temporarily employed for the purpose of construction. In other words, Mr. Chairman, my understanding is that the commission would take up the matter of permitting the issue of bonds, for example, upon satisfactory evidence that additional plant had been acquired with what was to all intents and purposes borrowed money, though borrowed from a reserve fund. I do not think there would be any difficulty whatever in procuring funds under these conditions. In fact, the employment of a reserve fund for such a purpose would seem to me to be perfectly logical.

It seems to me that no one can have listened to the paper just read by Dr. Humphreys without being impressed with the importance of the recommendations he makes with regard to uniformity in accounting with respect to assets, to operations, and to depreciation. In fact, the Doctor has so thoroughly covered the subject that it seems to me he has left very little to be said.

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Changes in the method of keeping accounts are not very quickly or easily effected. It is a long process, especially when, as may be the case with many companies represented here, the accounts reflect to a very great extent a corporate policy, with respect to the values at which the assets shall appear upon the books, and with respect to provision for depreciation.

I think the probability is that in the past the subject of depreciation has received very little serious consideration from corporations, both general and public service; but I believe that the time is coming when it will receive more attention from public service corporations, if not of their own motion, then by direction of public service commissions. I think in the past very likely the same variation has existed between corporations as exists between individuals; just as you find every degree of prudence and every degree of extravagance displayed by individuals, you will find every degree of prudence and every degree of reckless disregard of future possibilities displayed by corporations, with sometimes very disastrous results.

There is no doubt in my mind that a company whose accounts state the facts with regard to the value of its plant and with regard to its cost of operating, will have a great advantage in proceedings before any legislative committee or state or federal commission. In court proceedings the fact that a company's accounts state other than the fact will militate against it. The company whose accounts do not give correctly its operating results or which understate the value of its assets may be put in the position of having to prove that its accounts are wrong, and it will spend many unhappy quarters of an hour in doing so. The court would be seeking, of course, the facts with respect to the value of the property, and would accept testimony in this respect that might conflict with the accounts. It will save a company a good deal of trouble, however, if the accounts state the facts.

It seems to me that the Doctor's recommendation with respect to accounts is a recommendation looking rather to a change in corporate policy than to a change in the method of accounting. I think the conditions which the Doctor criticises

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with respect to the Massachusetts companies' accounts are due wholly to policy and not to accounting. In other words, I do not think that substituting one method of accounts for another is going to remedy such conditions. The Doctor's proposition, as I understand it, is that the accounts of public service corporations should show the actual value of their property. But would this rule work equally satisfactorily both ways? Its adoption might mean the writing up of values in some localities, and the writing down of values in other localities.

I have had occasion to observe, and incidentally to attack, the method employed by certain persons retained as experts in connection with rate litigation, and have noticed how their practice of adapting figures to their peculiar point of view has been facilitated by the absolute lack of uniformity in the records and accounts of gas companies.

With respect to the value of assets, however, I do not think that any court of law will attach much importance to testimony respecting the book value of plants distantly located as bearing upon the present value of the plant of a local company. I doubt whether a court could do so. The best evidence, and the evidence which the court is most likely to accept with respect to the value of the property, is the testimony of competent experts as to the cost of its reproduction, and the cost of putting it in a condition as good as new.

I am inclined to think that a recommendation, that depreciation be taken care of in anticipation, will not be received with equal enthusiasm by all companies. A suggestion to some companies that they charge anything more than current expenditures against current earnings, would not be very favorably received; other companies would agree to the principle in a general way but would reserve the right to modify it in its application according to the exigencies of their own situation. The majority, however, will, I think, lean toward a full and adequate allowance in current expenses for future contingencies.

With respect to depreciation I have had occasion to observe that what the court is likely to pay the most attention to is a company's history. A company that has done business for a

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number of years with plant of all ages is likely to have accumulated very useful data of a kind that I think commends itself most favorably to a court of law. There is an advantage also to be derived from having the accounts show very plainly all expenditures for repairs and current renewals, as well as final renewals.

Referring to the work the committee which has just been appointed will have to perform, I would suggest that with respect to repairs the system of the American Gas Light Association does not cover all the ground. There are some items of repairs that do not appear as such. For example, if my memory serves me aright, "distribution expense" includes the cost of repairs to buildings occupied by the distributing department and "office expense" includes the cost of repairs to office buildings. These repairs are just as important as any other, and ought to stand out as such, because in any consideration of the subject of repairs and renewals, and in any comparison between the operations of a company in different years, or between different companies, the figures shown in the repair accounts and in the renewal and replacement accounts combined will be carefully considered.

The line cannot be very closely drawn between what are strictly repairs and what are strictly renewals. In fact, we all know there is included in repair accounts a great deal which might properly be termed replacements and renewals.

My personal feeling is favorable to broad treatment of the subjects of depreciation and contingent expense. I believe that both are important; one no more so than the other. I am of the opinion also that there is no good reason why there should be any differentiation between the reserve for contingent expenses and the reserve for renewal and replacement in so far as their being included in the cost of gas is concerned. My judgment would favor including both of them.

I do not like the word "depreciation." It is a word that your opponents will use to your disadvantage. As a matter of fact, I think it can be expressed better. All of you know that depreciation from decay is not the only cause for displacement of plant. The greater loss is from displacement on account of

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supersession. You do not use your engine until it wears out. You use it until its capacity is no longer adequate for the load you have to put upon it. You displace other apparatus because it is not large enough to meet the demands made upon it. You rebuild holders because they are too small, or because you cannot buy additional ground advantageously. You continually have to tear down and build up. You do not give your plant a chance to wear out. Therefore, I would call this loss "supersession" rather than depreciation because the bulk of it is supersession. I believe that will prove to be the case with most companies represented here. It is the history of the company I represent which cover three-quarters of a century, taking the predecessor companies into account.

I think that if a company accumulates a fund equal to ten per cent. of the value of its property, and maintains such a fund, it is prepared for any contingency or emergency that may arise whether in the way of renewals, extraordinary accidents, increase in cost of material or labor, or decrease in the volume of business, or from whatsoever cause.

My method of creating such a fund would be to use a life table as a means of determining what would be a sufficient amount to put aside annually to take care of renewals. I would then determine what amount, in the judgment of my associates and myself, would be adequate to take care of such contingencies as an increase in the cost of material or labor; extraordinary accidents and things of that nature. I would take both amounts, and, finding what the total amounted to per thousand cubic feet of gas sold, I would use that as a factor for calculating the amount to be charged to contingent expenses every month, and credited to a renewal or contingent account, against which account I would charge annually final renewals and contingent expenses, and allow the fund to accumulate until it amounts to at least ten per cent. of the value of the plant and property.

THE PRESIDENT: Is Mr. Robert Grant of the Boston Consolidated present?

A MEMBER: He is not here, Mr. President.

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THE PRESIDENT: Mr. Cowdery, may we hear from you?

MR. COWDERY: Mr. Chairman, I was unable to read this paper of Mr. Humphreys before its presentation to-day, and in following Mr. Humphreys' reading I fear that my reasoning did not travel as fast as Mr. Humphreys' reading, and therefore, I believe that I am not able at this time to criticise Mr. Humphreys' paper in detail to any extent. I believe that this paper is one which we would have to give very close study to, and a great deal of it, before we would be able to reach a definite conclusion. I think it would be better, instead of trying to comment severely on this paper of Mr. Humphreys' to-day, if we were to allow it to rest and come before our meeting a year from now when criticisms in the nature of other papers written upon the subject perhaps could be taken up. I believe that in the coming year we are going to learn a great deal more about depreciation, so-called, than we ever have been able to pick up or learn before. I presume, so far as I have been able to follow the paper anyway, that in a general way, I quite agree with Mr. Humphreys in his reasoning. I think Mr. Humphreys has brought out a great many fine points in this matter that we have not materially thought of before. For instance, take the case of Mr. Forstall's examination of the Buffalo plant to determine the present depreciation of that plant. I think there is a very great point made there for which we will find a great use.

Further than this, I do not believe I can comment upon the paper.

THE PRESIDENT: Before closing the consideration of this paper I would like to ask Mr. Barker of the Massachusetts Commission, whom I am very happy to see here, for any suggestion that may occur to him.

MR. BARKER: Mr. President, I recognize the kindly intent on your part in asking me to say something upon the subject now before the Institute, and I appreciate your kindness. I think I would appreciate it still more if I had received some notice in advance that I would be asked to speak.

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The importance of depreciation in supervision and in rate making has always been recognized by the Commission of which I have the honor to be a member. It has not always been easy, however, to determine the fair amount to be allowed therefor. It seems to me that the very able paper just read suggests in striking contrast the method of approach of a man who regards this subject from a purely theoretical point of view and that of a man who combines the academic knowledge with practical experience. It is a business proposition, and as such, I think all fair-minded men will appreciate the importance of a practical knowledge of the business for its wise and safe solution. We have never in our administration been led very far by a purely academic presentation of this important subject. A theoretical study of the question has its value and may aid in solving the problem, but it cannot alone complete the solution. The determination of the proper amount to be provided in any year or in any series of years is the most complex question with which a manager has to deal. He must bring to it all of his own experience and that of others, so far as he can ascertain it, and upon the wisdom of his final decision will largely depend the success or failure of the corporation under his care. No board of directors would be likely to select a man without business experience however able his theoretical knowledge might be, as a manager of a large property entrusted to their care, neither would they make him their engineer-in-chief. The problem of depreciation charges is a business question first and foremost. You will agree with me so fully, I am sure, that I need not spend time to demonstrate this proposition.

I think it was a very pertinent remark of Mr. Carter's when he said that the determination of the question of depreciation in accounting is a question of public policy more than a question of mere accounting and the method by which it is to be handled will be very significant of the general policy of the corporation which will be affected by the business necessities of the situation. It always has been so and it probably always will be. In any attempt at supervision I think that if we are to fairly and sufficiently regard the ultimate public interest, we

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shall approach the depreciation problem as a purely business proposition.

I do not think, Mr. President, that I ought to take up your time further. A great deal of attention has already been paid to this important subject and I assume that it is to have more consideration by the Institute at some other time.

MR. A. E. FORSTALL: Mr. President, I want to emphasize a little the method of treating depreciation to determine the present value of a property, as illustrated by the case with which my name has been connected in the paper. It has seemed to me that the only way in which to determine the then present value of a property at any particular time is to first determine its cost of reproduction absolutely new, and then to determine the cost of putting the existing plant in a condition that is equivalent to being absolutely new. That is the way in which I always work, and always expect to work. Of course, that brings in both the question of physical decay, and that of its adequacy with reference to the amount of work required by the company, because the latter affects the question of whether it is worth while to put the apparatus into a condition as good as new. If it is not, why then, of course, that has to be taken into consideration. But, assuming that that is the correct way of getting at the present value, this leads me up to the point of saying that a great deal of stress ought to be laid upon the statement made in one of the conclusions of Dr. Humphreys' paper, that the life table should be corrected and amended from year to year as required by changes in existing conditions. The tendency of such experts as Prof. Marks, and Mr. Adams, and others of that class, is not to base depreciation upon the condition of the plant, but to take, for example, a piece of apparatus and simply to say that since its probable life is thirty years, and it has been in use ten years, 33⅓ per cent. of its value has gone. Now that seems rather extreme, but in a case with which I was connected, Mr. Adams did take a piece of apparatus and attempt to fix its value in just that way. He acknowledged, however, that, so far as he knew, it was in good condition and perfectly adequate for the purposes of the company,

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and for any purpose that they might require for ten or fifteen years in the future. But his contention was that so many years is the average life, and that 30 per cent. of these had passed, and that therefore that piece of apparatus was worth 30 per cent. less than a new one.

Now in regard to the figures on our books, I think that if we rely too much on estimates of yearly depreciation without making actual examinations to find the value of the plant, we will lay a certain amount of foundation for adverse theories of that kind. We want to be very careful to avoid that.

Another point that has been made by these so-called experts is that the idea of charging each year the actual loss by depreciation for that year instead of taking care of depreciation by a sinking fund is a theory that has been brought up in the last two or three years to meet the exigency of the occasions which have arisen. Bearing on that very important point we have this quotation from Dicksee on page 336, also one from Mr. Leake, and there is also a quotation that I would like to call attention to by Matheson, given in his book, "The Depreciation of Factories," in which he states that the cost of depreciation is the annual loss through depreciation. With their experience, I think it is fair to assume that other people can look at it in the same way without much hesitation.

Now as to the reserve to cover contingencies like changes in the price of material, and things of that kind. The necessity for that was strikingly impressed upon me by this same case that was spoken of where Mr. Adams took off 30 per cent. on apparatus as good as new. I claimed that 5 cents per thousand feet of gas made should be set aside as a reserve to meet possible increase in prices of material and other contingencies. I was not cross-examined particularly on that, but after the hearing the Chairman of the Commission, who was hearing the case, met me at the station, and while waiting for the train to come to take us out of town I had a conversation with him, and he rather took me to task for that on the ground that it was too much, because owing to the high cost of materials at the time he thought prices were not apt to go up. I acknowledged that prices were high, but told him that even so there was ne-

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cessity for a five-cent reserve. That company is now paying a half a cent more per gallon for gas oil than they were at that time, and that alone makes a difference in cost of gas of over two cents out of every five already.

MR. P. F. YOUNG: Mr. President, I have been much interested in Dr. Humphreys' paper. No one, after hearing it read, ought to be confused between the actual cost of depreciation and figures obtained from methods of treating same. The balance sheet of a company should represent the company's exact condition so far as that is possible. If we fail to take up depreciation charges on physical property the only tenable theory that we can advance for not doing so is that the value, not shown on the Balance Sheet, of the intangible property of the Company, franchises, good-will, etc., is equal to the amount of depreciation we fail to take up.

The paper that Dr. Humphreys has read is, I think, unique. It is remarkable how very little literature there is on the subject of Depreciation. Dr. Humphreys has referred to the works of Prof. Dicksee and Mr. Forstall to Matheson's work on "Depreciation of Factories." Dr. Humphreys has also mentioned a paper by chartered accountant, Mr. P. D. Leake, and Dr. Humphreys has now made a notable contribution to the subject.

The names of Dicksee and Matheson are those of authorities on this subject and we must now add the two other names to our list.

Mr. Carter has suggested the term "supersession" for use in place of the term "depreciation." While I think the term supersession is a good one, I should not be in favor of doing away with the use of the older term. Depreciation is a word that has come to mean a great deal. Its usage has been general. Accountants in England have always used the term as covering all of the three elements that Dr. Humphreys has named. Accountants in this country have followed that practice. The term "depreciation" is so well understood and has become so intimately associated with its various constituent elements that I do not think it would be a good plan to discontinue its use.

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The question of how much depreciation should be shown in our accounts is, of course, another matter. We know there is such a thing as depreciation and we can approximate its cost, but how it should be brought into the accounts is a matter that requires careful consideration.

I have been attending this week a convention of the American Street & Interurban Railway Accountants' Association, which is very much interested in this matter of depreciation. They have a committee on a standard form of accounts. This committee is working in accord with the Interstate Commerce Commission and with various state Public Service Commissions.

The Committee on uniform accounting of the National Electric Light Association are to hold a joint meeting with this Street Railway Committee, and the subject of "depreciation" will probably be given more consideration than any other matter.

The resolution which was offered by Mr. Doherty is a good one.

We want a committee on accounting that has an understanding of accounts to co-operate with the railway and electric lighting committees so that this important work relating to accounts may be properly considered.

I have always regretted that Gas Associations generally have not paid more attention to accounting, and I hope this paper will mean a departure from that policy.

A MEMBER: There is one point which has been brought out I think, and that is one which makes you think how necessary it is to be absolutely exact in charging off matters of depreciation. When it comes to making your factory returns jibe with your books, then watch out, and do not put too low a value on your plant or the municipal people will take it up. It makes you think how very close you must watch yourself.

THE PRESIDENT: I will take this occasion to make a couple of announcements. No banquet tickets will be sold after ten A. M. to-morrow morning. Mr. T. C. Jones, our Treasurer,

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says that he would be glad to receipt for any dues which may be due to the Institute.

Now is there any further discussion on this paper?

DR. HUMPHREYS: Gentlemen, I feel that I have taken too much of your time already, but there are a few things I should like to add, which will take but a few minutes to say.

I thank you for the discussion so far as it has gone; I will refer only to some of the points which have been made.

Let me refer to the statement made by Mr. Young as to the limited amount of literature on this subject. There is one important paper which was written some years ago, and which has not been mentioned, and that is a paper which was prepared by Mr. G. G. Ramsdell, and read before the New York Society of Gas Lighting. Whether that is now open for general reference I do not know, but I presume it is so.

With regard to Mr. Carter's reference to the fact that the courts probably would not accept as of material importance the valuations of plants located at a distance as affecting the valuation of a local plant, possibly that may be the case in some courts, but I am sorry to say that I have not the same amount of confidence in all the courts. As to the New York Commission, recently deceased, I know it was not so, and he knows it was not so if he will stop and reflect a little. In the New York Consolidated Gas case evidence was brought in by the experts against the Company as to the value of plants, some of them three thousand miles away, and when I went in to testify against that evidence, and to show the inapplicability of some of it, I wasn't allowed to testify on any of those places. Outside of the record one member of the Commission asked me to favor him with a copy of my rather elaborate tables prepared for use as evidence, making the statement that they would be, no doubt, of great value to the Commission—but notice, this was to be outside of the evidence.

Mr. Carter also made a remark in regard to the history of a plant commending itself to the court. It should. That lies at the very basis of what I am trying to urge in this whole

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matter, but if that history is not a correct history it is of no value or worse than no value. If such a company as his can go back for thirty years or more, and show a correct history, and show the values as they actually existed it is of commanding importance.

Now I still prefer to differ with Mr. Carter on the question of the difference between Depreciation and Contingency Reserve. We differ on very few points, as Mr. Carter knows. I contend that on the very point of exactness in accounts as to which he is properly so particular in emphasizing, that we should distinguish between the two. There is, of course, a very essential difference between depreciation and the reserve held against contingencies which may or may not materialize. We know that depreciation will materialize. We know that year by year there will be an item of cost for depreciation; we are not so sure as to the item covered by contingency reserve. That might be regarded as a cushion between cost plus return on our investment and price charged per thousand.

Now I want to say a word or two about Mr. Barker's criticism. I am not quite sure whether I took in his criticism accurately or not, but what I really understood was that he thinks that this subject ought to be treated from a practical standpoint; that I have not been so treating it, but that I have been treating it from a theoretical standpoint. I suppose in that case that my thirty odd years of practical experience is to be wiped out, and that my experience of five years as a college president makes me a theoretical man and disqualifies me from being a practical man.

MR. BARKER: Oh, no. Nothing of the sort. I would be the last man to suggest any such thing. I think what I said was this: that the paper showed a marked contrast between the method of approach of the purely theoretical man, and the man who combines both theory and practical experience, as Mr. Humphreys certainly does. (Applause.)

DR. HUMPHREYS: I will take it all back, Mr. Barker.

MR. BARKER: I tried to make myself clear, but if I con-

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veyed any such impression as that I am very sorry. I did not intend to.

DR. HUMPHREYS: The fact is, I evidently did not understand Mr. Barker. I thought he was making the suggestion that my paper was purely a theoretical discussion of the subject, and it would have to be considered from that standpoint. It must, of course, be considered as a business question, and if you will refer to pages 352 and 353 you will find that I have done so. We must take up and consider every phase of the matter when we are considering the question of depreciation, namely, from the standpoint of the constructing engineer, the operating engineer, the man of business, and finally that of the accountant.

I would like to refer once more before I close to the question which came up as to the use of terms. I quite agree with the gentleman who objected to doing away with the term "depreciation," and, on the other hand, I do agree, to a certain extent with the idea of employing terms which could be more easily understood. In my lectures to the Stevens students I am very apt to push "depreciation" aside as much as possible, and to lead the young men on to appreciate that after all depreciation and repairs or maintenance are firmly bound together, and that they cannot be separated. I rather divide up the subject under these heads: repairs and current renewals, deferred renewals, as for instance, the refilling of retort benches, and final renewals, the last being what we would ordinarily call "depreciation," but I try to treat the whole subject of wear and tear and depreciation under these heads just named, and I use those terms a great deal more than I do depreciation, but I also define depreciation in connection with the terms I more often use, because the student must be prepared to know what the term depreciation is supposed to cover.

I thank you, gentlemen, and apologize for taking so much of your time.

THE PRESIDENT: I would like, before adjourning, to ask the Committees on Next Place of Meeting, President's Address,

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and Nominations if they will be ready to report from 10.45 on, to-morrow morning.

DR. HUMPHREYS: According to the by-laws the Nominating Committee must report the first day, or there must be twenty or more members objecting. Are you going to have enough to carry it over?

THE PRESIDENT: There was unanimous consent given to the postponement of the report this morning, and that amounts to a suspension of the by-law. Will those Committees please be ready to report to-morrow morning?

We will now adjourn until to-morrow at ten o'clock.

The Institute adjourned to 10 A. M. Thursday, October 17th.

SECOND DAY—MORNING SESSION.

Convention called to order at 10:05 a. m., President Walton Clark in the chair.

THE PRESIDENT: The meeting will please come to order. The first business of the morning is the report of the "Wrinkle Department," by Mr. M. R. Bump, Editor.

MR. BUMP: Mr. President and Gentlemen, I was rather unfortunate in getting a late start on the work of the Wrinkle Department this year, and also in being away from my office a good deal of the time, and some of the material I was unable to get in shape to put into this report, and therefore I merely put in what I had time to get in shape, and what came in in time to hand to the printers. The consequence is, I have considerable material which I can hand to the Editor of next year's Wrinkle Department, and which I think will prove of value. I desire to present the material as contained in the proceedings, and also desire to thank the members of the Institute for the valued assistance which they have given me. Considering the late start, the results reflect credit on the co-operative spirit of our members.

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WRINKLES 1907.

M. R. BUMP, EDITOR.

ELECTRIC CUT-OFF FOR RELIEF HOLDER PROTECTION.

This device consists of a heavy magnet, revolving drum and cut-off attachment for releasing drum when wound up, all attached to heavy wood base, so that the apparatus may be attached to any wall.

B. & C.—These are pole pieces and moveable armature of a strong magnet attached to P, an iron support, with binding post extensions; and O, a two-piece bracket having pivot holes, or journals in which the extended axles of C work.

Armature C is connected with pawl A1, and moveable lever E by means of a "T" shaped lever D, so that when D is raised contact is made between binding post H and lever E, and pawl A1 is pushed into a notch of A, thus blocking the movement of A. If D is lowered, it cuts the circuit and releases A, which is free to revolve as the weight drops, thus drawing down on the cord connected with a quick closing valve Z, which is placed in the steam supply line of the exhaust engine. This downward jerk closes valve Z and stops the exhauster.

(E) is separate from (D) and pivots on the end of horizontal arm of D, as well as at the end of F, so that downward motion of D at the pivot point causes upward motion of E at the point of contact with H.

Direction of Current. Current comes in over line wire Y to binding post N, then to binding post G and to connection E at L; through E to H (when contact is made), then to small wire passing through magnet coils and down to M, then to the knife switch K, which is merely a cut-off to break the circuit.

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K is not necessary when there is no contact at top of holder. If only one contact on the holder is used, and that one at the bottom, the machine will not stop the exhauster when the holder reaches the top, so that one setting each time it trips will keep it in readiness for work. We use signal lights for top connection on relief holder, which are cut in on the same circuit as the cut-off; therefore leave knife switch open until ready to let the holder down for the last time, then close it and raise D; this makes the circuit complete at E and H and raises the armature C.

As the current excites the magnet coils, C is drawn down which releases A and breaks contact, so no heating effect is obtained in the coils of the magnet.

A window weight is attached at the end of the moveable cord, and as it drops, the drum is revolved and the cord leading to the valve is wound up, pulling up on the handle of the quick closing valve on the steam line, closing it and shutting off the exhauster.

This cord can be run for quite a distance over pulleys and in any direction if necessary.

Q is a cast iron support for A, being made from a reel used for raising street arc lights.

I is a piece of ebonite insulation and I a thin sheet insulator to keep the current from sparking across from support of H to support of moveable armature C.

Pulley J simply deflects the cord and gives a greater arc of contact between the cord and drum.

Holder Contacts. For contact with the holder, use a brass "T" shaped strip extended from the guide wheel frame and connected to a free wire at the top of the holder, so that the movement up and down will not be retarded or interfered with in any way. This free wire should be connected to one of the line wires of the circuit. For contact at the bottom, the other line wire should be connected to a stationary brass spring about nine inches long by two inches wide, fastened at one end and arched so that when the movable contact on the holder touches it, it may move freely over the spring; and if the holder should be allowed to go so low that this movable

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contact passes the spring, in returning it will not be obstructed and make a contact again on the upward movement of the holder.

Bells and lights for signals may also be cut in by the same contact if so desired. If all connections are properly made the machine should not allow the holder to drop more than an inch and a half after contact is made, and the exhauster should be stopped within a few revolutions after the drop is released.

W. R. RHODES,
Supt. Springfield (Ill.) Gas Light Co.

Ill., No. 1.

CHANGING WET LUTE TO DRY LUTE PURIFIERS.

This method consists in filling the water lutes with concrete and making a neat cement face on the top. The covers of the boxes were cut at the corners and spread until a flat surface was made all around to cover the cement face. They are held in place by anchor bolts imbedded in the concrete, and a gasket, consisting of cotton hose covered with graphite and boiled oil, is used.

THOMAS CRAWFORD, Gen. Mgr.,
Clinton (Iowa) Gas Light & Coke Co.

TEMPORARY SCAFFOLD UNDER BRIDGES.

This consists of made up vertical and horizontal pieces which can be quickly assembled, as shown in the accompanying sketch. The horizontal pieces are of smaller diameter than the vertical and simply slide through the tees.

A. J. DALY, Supt.,
North District Laclede Gas Light Co.,
St. Louis, Missouri.

Ill. No. 2.

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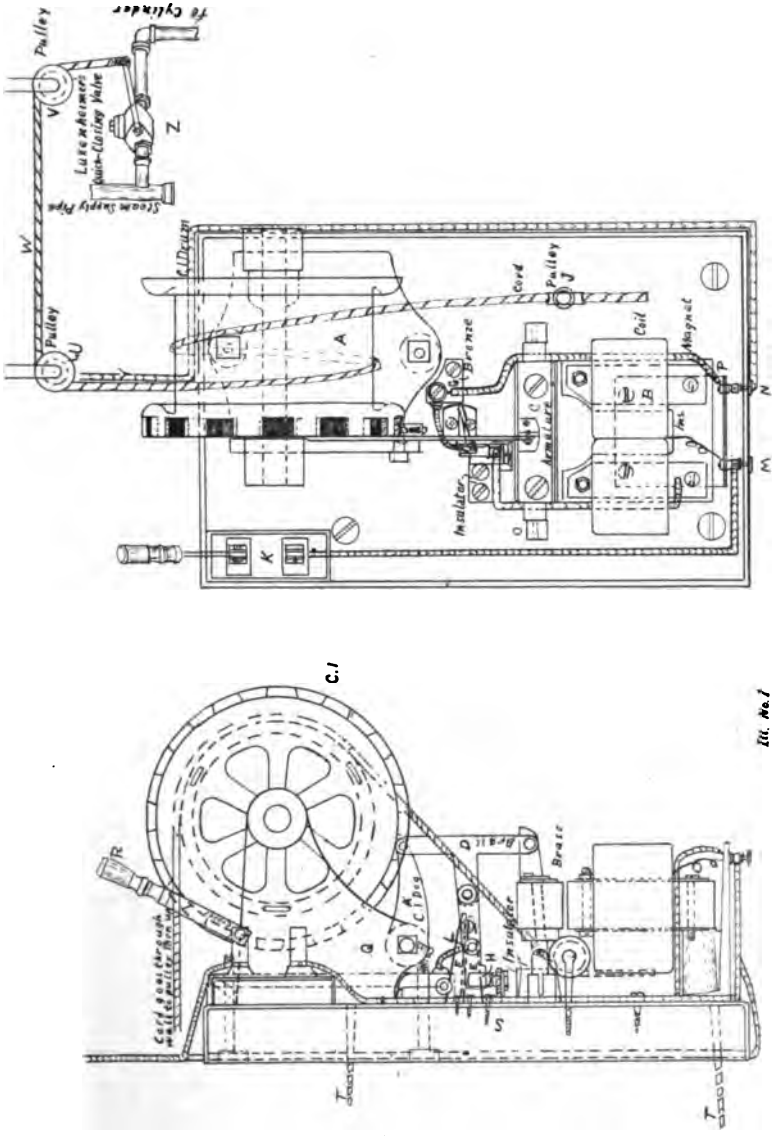

Ill. No. 1
ELECTRIC CUT-OFF
for
RELIEF HOLDER PROTECTION

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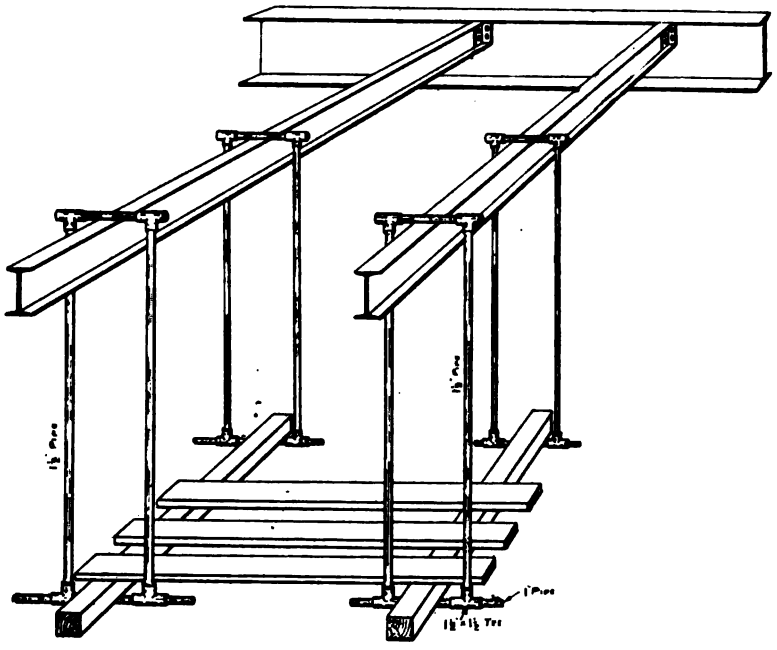

HANGERS FOR SCAFFOLDING SUPPORTS UNDER BRIDGES ETC.

Ill. No. 2

PROTECTION FOR BLAST PIPE LINES.

In addition to the contrivances ordinarily employed to avoid explosions in blast lines, we have found a very effective way to further protect the blast lines from explosions or kick-backs. This is accomplished with a device constructed as follows:

Cut a hole in the tee that is connected with the blast valve of the generator—hole to be about one-half the area of the blast pipe—and rivet in the tee around the hole a double flanged ring. Between the ring flanges place a piece of 1/8 inch sheet asbestos across the aperture. In case of leak from the blast valve, the explosion will blow out the sheet asbestos and thereby save the pipe.

W. B. CLINE,
Los Angeles Gas & Electric Co.

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Asbestos Rope for Gaskets on Dry Lute Purifiers.

We formerly had considerable trouble keeping the cover joints tight on our dry seal purifiers, especially when the gas was hot or the pressure high, say from 60 to 80 inches of water. Red lead putty was satisfactory in the days when the pressure was from 20 to 40 inches. We now use asbestos gaskets on all our purifiers. An asbestos soft-twisted ¾ inch rope is used as a gasket, and such a gasket has held perfectly tight with 87 inches of pressure. Before setting the gasket, apply a thin coat of red lead to the top of the purified box where the asbestos rope is to be placed. After the gasket is set and just before setting the cover of the box, apply a thin coat of a paint composed of a mixture of graphite and oil to the under side of the cover where the flanged part will rest on the asbestos gasket on the top of the box.

The asbestos is far cheaper than red lead putty and, if set in the manner just described, will last from twelve to fifteen months without renewing, and it forms a very tight joint, preventing leakage of gas in the purifier house.

W. B. Cline,
Los Angeles Gas & Elec. Co.

Stopper for Gas Off-Take,

to enable blasting generator while seal or scrubber is being cleaned.

A convenient valve or stopper for a gas off-take pipe between seal and generator, which will enable the operator to blast his machine while cleaning seal, and will also prevent any danger from explosions between seal and generator while cleaning or preparing to clean seal or wash box, is constructed as follows:

Take a piece of sheet steel about ¼ inch thick and have a steel disc made about 2 inches greater in diameter than the cross-section of the off-take pipe. This disc should be "dished" about 4 inches, and an eye bolt fastened in the centre. It is then placed in a cage on the under side of washer diaphragm directly under gas off-take pipe, and the off-take pipe beveled

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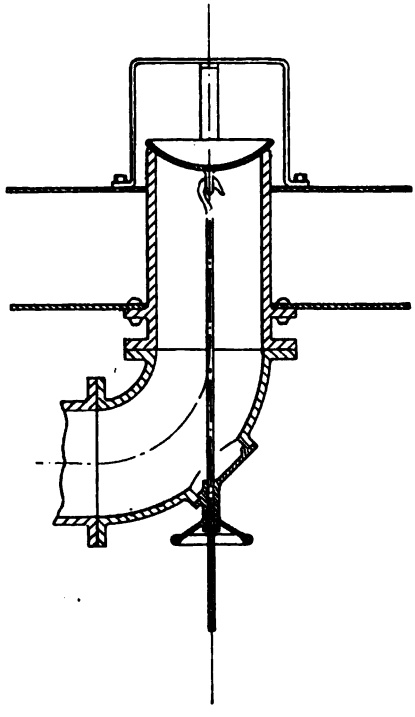
on the inside edge to conform to the "dish" of the disc. A rod, one end of which is hooked to the eye bolt in the disc, is then passed up through the cleaning elbow and door of the off-take pipe—a small hole having been cut in door to admit rod, and a rod throat attached to door through which the rod is passed. The upper end of the rod for about 15 inches of its length is threaded, and with the aid of a 6 inch hand wheel



Ill. No. 3—Stopper for Gas Off-Take.

with a thread cut through the centre, working on the threaded rod, it is a simple matter to screw the disc tight up against the beveled edge of the gas off-take pipe. The cage that holds the disc is made of two pieces of 2 inch by ½ inch flat iron bent at right angles and crossed at center, with a bolt at the intersection, and the four ends cap-screwed to the under side of the diaphragm. The cage should be made as deep as the

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cross section of the off-take pipe. When the stopper is not in use (when the generator is running), the disc rests on bottom of cage, the rod and wheel having been taken out of elbow entirely.

W. B. CLINE,
Los Angeles Gas & Electric Co.

Ill., No. 3.

HIGH PRESSURE DRIP COCK WRENCH.

This wrench is designed for use in opening the cock for blowing high pressure drip boxes.

C. J. FOX,
Suburban Gas Co., Chester, Pa.

Ill., No. 4.

REPAIRING A CRACKED COMPRESSOR CYLINDER.

The following method was used in order to make quick repairs to an 18 inch diameter cylinder which had been cracked by fire, which destroyed the roof of the compressor room:

The inner cylinder was cracked through half its circumference. Starting at one end of the crack, we drilled a ⅛ inch tap hole for ⅛ inch pipe thread, plugging this hole with an ⅛ inch pipe threaded rod and cutting off flush with the cylinder. Then along the crack we drilled a second hole overlapping the first plug, and plugging it with a threaded rod as in the first case. We continued this treatment throughout the entire length of the crack, which required 130 holes, practically forming a solid plug throughout the entire crack. This immediately stopped the water leak and also the gas leak, and we believe the outer shell of the cylinder is strong enough to hold the inner section, and that the cylinder will now last the lifetime of the balance of the compressor.

This same method may be used in repairing boiler cracks. It might not answer on a single casting like a steam cylinder, as in that event it would act as a wedge and tend to split the cylinder further.

J. D. SHATTUCK,
Suburban Gas Co., Chester, Pa.

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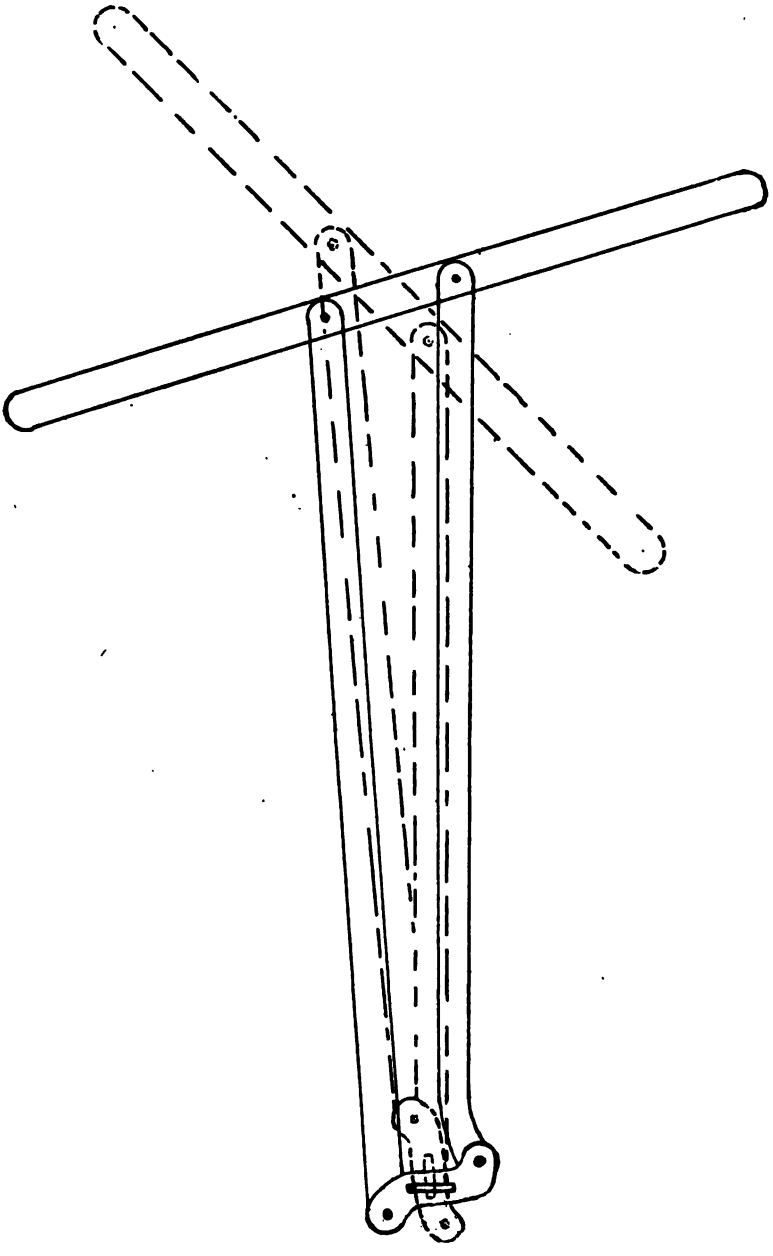

ILL No. 4
HIGH PRESSURE DRIP COCK WRENCH

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Repairs to Damaged Relief Holder.

The holder was damaged by being drawn down against a 4 inch "U" pipe, used for pumping tar into the holder tank, and which had slipped out of place and come in contact with the cup of the inner lift of a 200,000 ft. relief holder. When discovered, five goose necks were broken off from the inner section, the balance were off the guides, the holder was canted about two sheets, and the cup was rolled like a piece of paper where the pipe struck it, and the holder badly buckled on the side. The damage occurred during a storm and the water gas maker relied on the tell tale which showed no sign of the trouble. Holder makers said the only way to repair the damage was to land the section, clean the tank which contained 100,000 gallons of tar, raise the outer section by jack screws and cut out and replace the damaged portions. Instead of this method the following plan was employed:

We first landed the section, thoroughly ventilated it by air blast, syphoned two inches of light oil from the surface of the tank by means of inverted syphons working near the surface. We then blew the inner section up with air. We cut holes through the grip of the outer section at each column and inserted through these holes heavy hooks that had been made. (Ill. No. 6.) These hooks we attached by means of a two-inch hemp cable to the horizontal girder. The pressure gauge on the holder designated a pressure of 3 inches. The air was permitted to escape until there was a $^{7}/_{10}$ in. pressure on this gauge and the crown was just waving. This stretched the cables nearly one foot. We then tied the goose-necks to the column as securely as possible and then let the balance of the air out of the section so that the goose-necks took some of the weight. We found that we had succeeded in hanging the section level and it stayed level throughout the three weeks that it hung on the cables, the cables stretching during that time nearly another foot. We then drew the water down in the tank below the cup and proceeded to cut out the damaged section of the holder (as shown in print No. 5), and took out the bent cup, sent the piece to a nearby ship-building place and had the channel iron re-rolled. We put this section of the

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cup together on the ground and were able to re-insert it in place with very little difficulty, contrary to advice given us by holder people, who said that the holder would spring together at this point when the section was cut out, and it would be practically impossible to force it apart and put the piece in again. As a matter of fact, this was easily wedged into place.

The most difficult job of the entire work was to bend about two feet of channel iron of the next section. We did not wish to cut any more than the one section, and in order to bend the bent piece back by hand we made a number of tools. We also made a number of tools to drive up the rivets in the cramped corners. We succeeded in driving up every rivet but three on the work. The end that was bent badly and which we re-shaped in place by means of the above mentioned tools is not perfectly true, but it is joined up with the section that was cut out, and has made a tight job. The load was 8,200 pounds on each cable and column.

The air was kept pure in the holder by means of a canvas air blast. The entire work was completed in about three weeks and at a cost of about one-third of any estimate given us by holder builders for making these repairs, and also without accidents of any kind.

J. D. Shattuck,
Suburban Gas Co., Chester, Pa.

Ill., Nos. 5 & 6.

Store Room System.

Bins are arranged with all fittings of the same size in a horizontal line and all those of the same kind in a vertical line. To the top of each bin a tin drawer is fastened. Checks are stamped with the first letter or number of each account. When any number of any size of fittings is withdrawn, that number of checks are put in the drawer indicating what use was made of the fittings. At the end of each month, the checks are withdrawn and counted, and the total withdrawn entered on the store room record. They are then classified and counted for report of materials on different classes of work. The in-

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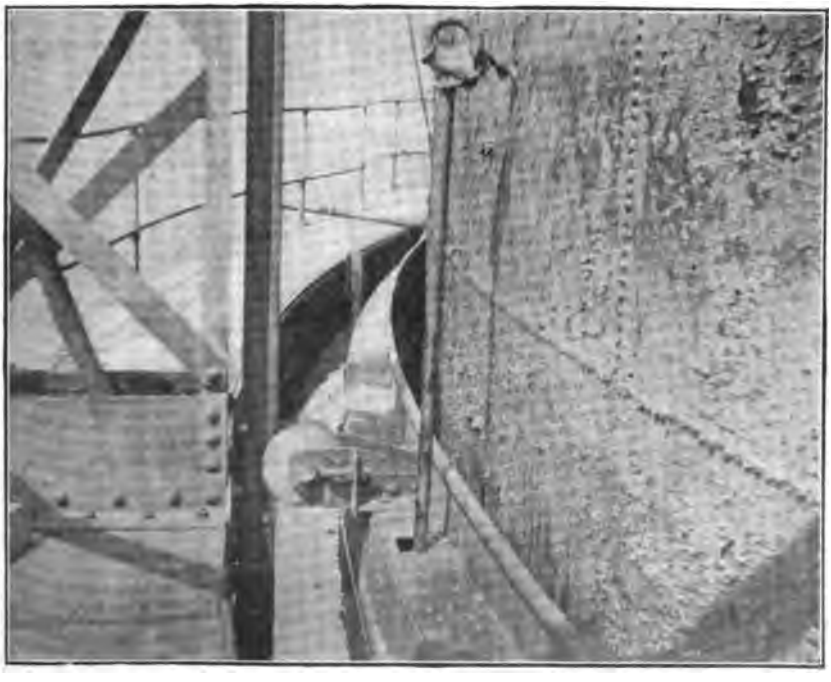
Ill. No. 5—Damaged Relief Holder.



Ill. No. 6.

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ventory is then checked by means of cards in each box, showing number purchased and used each month. This system saves a great deal of clerical work at the end of the month and enables the storekeeper to keep very close account of his stock.

C. A. WERBER,
Atlanta (Ga.) Gas Light Co.

METHOD OF SEALING OFF WORN OUT RETORTS.

Where several retorts are connected to a single pipe and it becomes necessary to blind one of them, considerable difficulty is encountered in making a tight job by the ordinary method of building a single 12 inch brick wall inside the mouthpiece. In order to overcome this difficulty the following plan has been successfully employed, with the result of materially increasing the candle power:

Build three walls of single brick thickness; the first about one foot inside the retort; the second just inside the retort, and the third in the mouthpiece itself.

The first wall acts merely as a deflector of heat from the second wall, which should be built as carefully as possible and mudded thoroughly with fire clay. The third is also carefully built and so placed that even if air does leak in between the mouthpiece and retort, that it cannot be drawn into the gas.

PAUL MCMICHAEL, Supt.,
Atlanta (Ga.) Gas Light Co.

CHECK SYSTEM FOR METER REPAIRERS.

Each man in repairing a meter is required to solder a number or tag, indicating date meter was repaired, on the bottom of the meter and on the left side near the top place, his initials. Should there be any further trouble with the meter, a glance will show when and by whom it was repaired. Also on the inside on the back plate the repairer writes the nature of repairs made by him. The result has been to make the repair men very careful in their work.

GEO. W. ACKERMAN,
Atlanta (Ga.) Gas Light Co.

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Charging Device for Inclined Retorts.

One of the objections urged against the use of the inclined retort system, especially at small gas works was, that the cost of coal storing and charging apparatus would be out of proportion to the advantages derived by reason of simplicity in drawing and charging the retorts as compared with the horizontal retorts.

We have had in successful operation during the last twenty months a simple device for charging inclined retorts which may be largely explained by means of the accompanying photographs.

Illustration No. 7 shows a "Farmer's Dump Wagon" in which the charge is carried from the coal shed, weighed, and then raised to the charging floor, by means of a common hydraulic elevator; to be dumped into the retort as shown on the illustration.

The wagon is loaded for one retort only; as our charges are governed entirely by the quantity of gas required; and range from 400 lbs. to sometimes over 600 lbs. per charge; the duration also ranging from 4 to 6—or even 8 hours, regulated by the necessity for gas as just mentioned.

The lower retorts are charged by the dump wagon being rolled to the open mouthpiece of the retort, and then tilted until the contents of the wagon are in the retort.

The evenness with which the charges distribute themselves leaves nothing to be wished for. The upper retorts are charged in like manner; only that in their case, the elevator must lift the wagon a little higher; which is then rolled upon a small wagon with a flat platform top.

This is then rolled up to the retort, and the charge dumped as before. (See Fig. 7.)

The actual time required to dump the coal into the retort is about 8 to 10 seconds, and the whole operation of drawing and charging, from the time the lids are opened until again closed, requires less than four minutes for one man to draw the charge, augur the stand pipe, charge the retort and close the lids.

B. F. Bullock,
Fredericksburg, Va.

Ill., No. 7.

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Ill. No. 7—Charging Device for Small Inclined Retort Settings.

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Shield for Outside Gas Arcs.

A simple shield to protect mantles from wind while cleaning outside arc lamps is made by cutting a piece of heavy canvas 28 inches long and fastening same on wires, as shown on the accompanying sketch.

Mr. Frazer, Battle Creek (Mich.) Gas Co.

Ill., No. 8.

Ill. No. 8—Shield for Outside Gas Arcs.

Respirator.

To Enable a Man to Work in a Gaseous Atmosphere.

The head piece is an ordinary workman's cap, to which is attached face protector made of sheet tin, oiled silk and clear

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Ill. No. 9.

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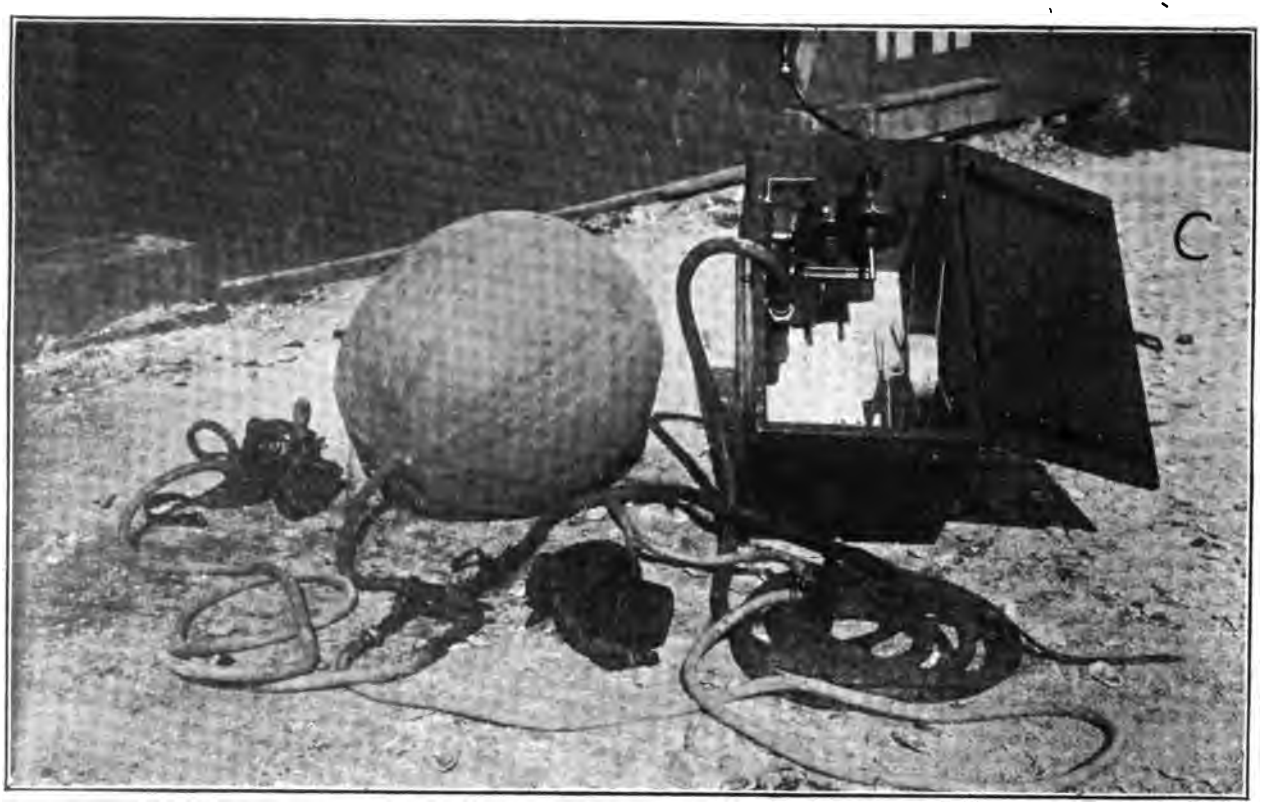

Ill. No. 10.

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Ill. No. 11.

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celluloid; rubber tubing attached to waist as shown; air supplied by centrifugal fan mounted in box; air pressure maintained uniform by large gas bag as shown, or by ordinary gas engine bag inserted in tubing. A constant pressure is maintained within the face protector, so that there is a constant outward flow around the edges at cheeks and chin. Two head pieces are attached to the pump, the tubing leading to each head piece being of 1 inch diameter, and the tubing from junction back to pump being 1¼ inch. This device is home-made.

United Gas Improvement Co.,
Philadelphia Gas Works,
Distribution Department.

PHOTO CUTS 9, 10, 11.

Meter Test Orifice.

This is a safety device used in turning on gas. It is not safe to depend on watching the meter dial for movement of the same, because there is no certainty that the meter is in such condition that it will register at small rates of consumption. If the meter has an internal leak, it will pass some gas without movement of the test hand, and thus deceive the person watching same. The orifice for sizes up to 100-light inclusive is made of cast aluminum, the disc is of brass, and the small hole is of proper size to pass ¾ of a cubic foot of gas per hour under 20 tenths pressure. When ready to turn on gas, the operator screws test orifice on meter outlet screw, disconnecting the riser, if necessary. Gas is then turned on meter and the operator observes if test hand moves within a stated time, as described in schedule furnished him. If so, he knows that meter is in condition to register a flow of gas at the rate of ¾ of a cubic foot per hour, or over. Test orifice is then removed, meter attached to house piping, gas turned on, and if test hand of meter shows no movement in same length of time, operator is sure house piping is tight and no burners are open. This test orifice is also found useful in complaints of leaks, as it enables the workman to form some idea of the size of leak

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in house piping, by comparing rate of movement of the meter, when attached to house piping, with the rate shown when the test orifice is on. For larger sizes the test orifice is made of cast brass with brass disc, as shown.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works,
Ill. No. 12. Distribution Department.

METER SETTING GAUGE.

This gauge is used in setting meters, its object being to strain the meter and meter screws as little as possible. The gauge consists of two meter screws mounted on a rod composed of steel tubing. One screw slides on the rod, and can be clamped when properly set. The gauge is first applied to meter to be set, the two screws on the gauge being adjusted exactly over the screws on the meter. The gauge is then used, instead of the meter, in making up the meter connection, the latter being adjusted so they hang in exact position before the meter is lifted to them. This practice reduces strains in meter screws, and thus reduces meter leaks.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works,
Ill. No. 13. Distribution Department.

METER COLUMN PUMP.

The drawing illustrates a hand pump for clearing water or condensation out of meter columns. It is harmful to the meter to turn same upside down in order to pour out this condensation. This is true of all meters, but especially so of those where the diaphragms are dipped in oil. The pump is made of 7/8 inch brass tubing, with handle and piston rod of 1/8 inch wire. The piston is a leather washer held by nut screwed on end of rod. This pump is used in several sizes to suit the sizes of meters.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works,
Ill. No. 14. Distribution Department.

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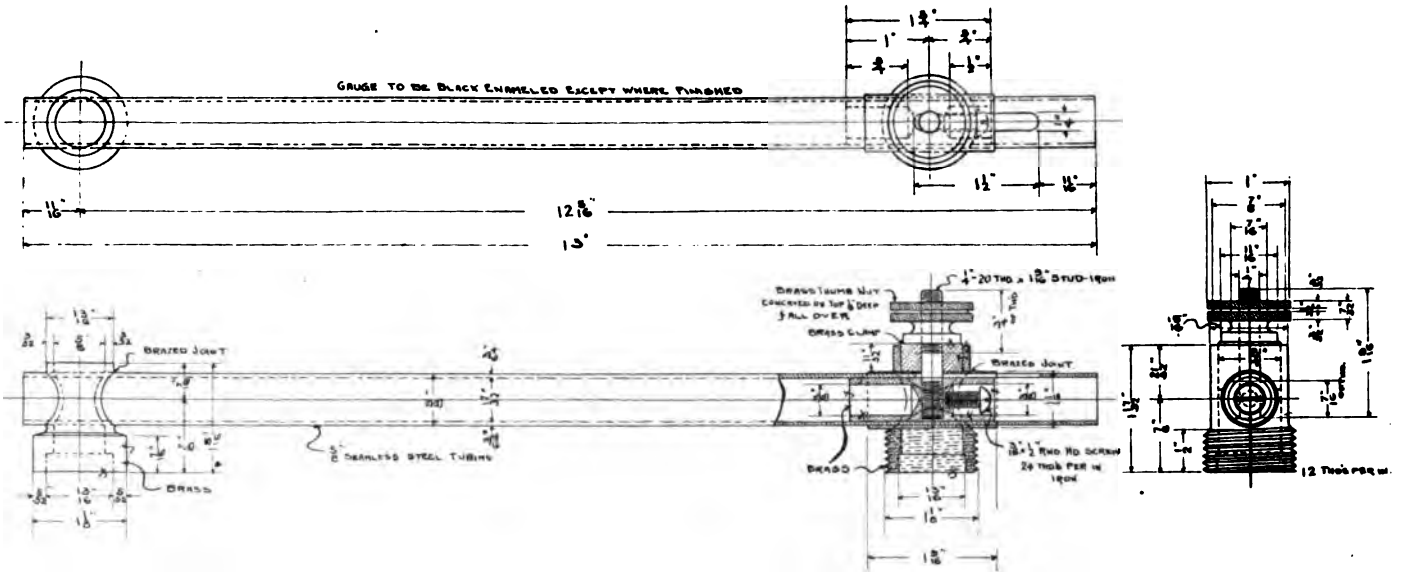

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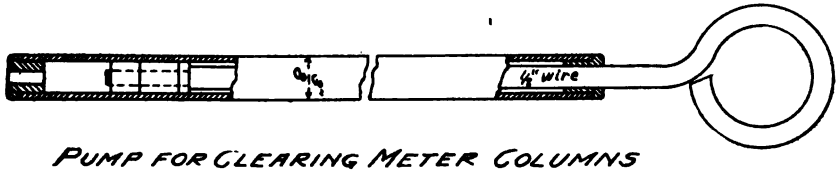

PUMP FOR CLEARING METER COLUMNS OF CONDENSATION

Ill. No. 14

STANDARD SERVICE DRIPS.

Where levels do not permit service to drip back to main, a service drip is inserted at the most convenient point outside of the building. It is considered bad practice to place service drip in cellar. The drawing illustrates the forms of drip used.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works,
Distribution Department.

Ill., No. 15.

SAFETY INDEPENDENT COCK.

The drawing illustrates a special form of independent cock, in which the nozzle on the side outlet for reception of hose is bent downward. This form of cock is used in order to lessen the risk of accident by a person inadvertently turning gas into the wrong pipe. In the ordinary independent cock, the handles of the two gas cocks (on the gas bracket and on the side outlet) are side by side, and one is easily turned in mistake for the other. In the form here described, the handle of the cock supplying the side outlet is on top of the fixture, and is thus easily distinguished from the handle of the cock on the gas bracket, which is always on the bottom.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works.
Distribution Dept.

Ill. No. 16.

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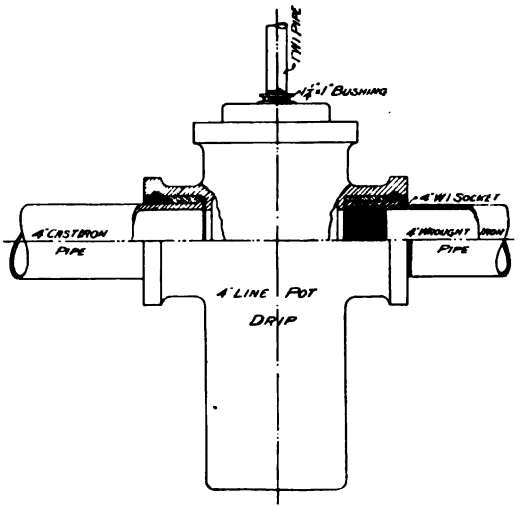
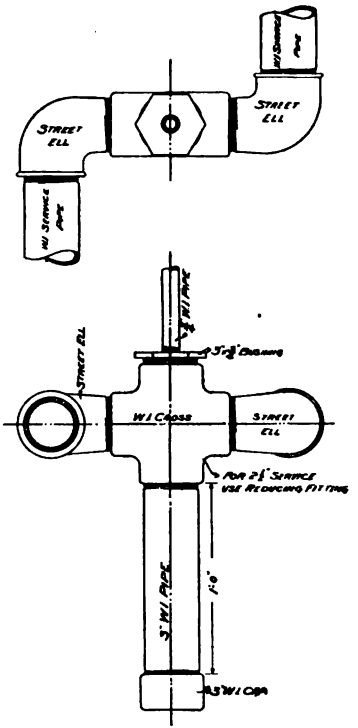
G.

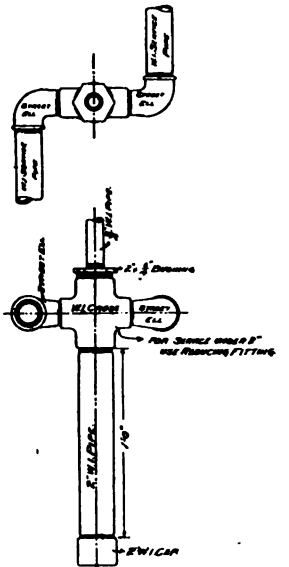


SERVICE DRIPS
FOR
4" CAST & WROUGHT IRON SERVICES

Ill. No. 15



SERVICE DRIPS
FOR
2½" & 3" WROUGHT IRON SERVICES.



SERVICE DRIPS
FOR
2" WROUGHT IRON SERVICES & UNDER.

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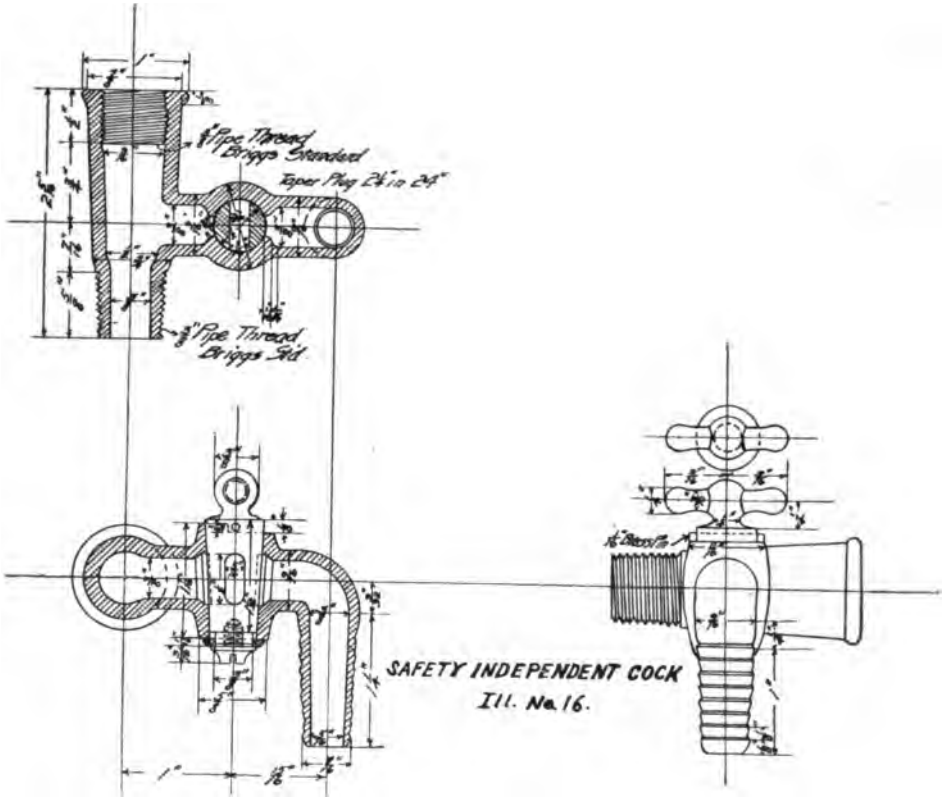

SAFETY INDEPENDENT COCK
Ill. No. 16.

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Union Joint for Rubber Tubing.

In the drawing this joint is shown as applied to the safety independent cock, described in number 16 above, but this joint is applicable for the connection of appliances with rubber tubing to any other design of fitting. For use with this joint, the tubing is purchased with brass ends, tapped with ¼ inch pipe threads. The joint is of the regular union pattern with nut and tail piece, but, instead of being of the ground joint type, the gas tight feature is obtained by the pressing of a sharp edge on the soft metal conical end to the tail piece. This feature permits of several independent cocks being attached in different rooms, and the gas heater or appliance with the tubing and tail piece, carried from room to room and connected where desired. The advantage is a greater safety, as it is impossible for this joint to slip or pull off as can the ordinary slip joint. The joint can, of course, be made gas tight by screwing the nut by hand, so that it is an easy matter for consumer to move the appliance from one location to another. At the appliance end of the tubing, a threaded connection is made by the fitter, and this, of course, need not be disconnected by the consumer. On any appliance where there is danger of the heat from the burners being conducted to, and injuring, the tubing, a distance piece or nipple about three inches long is used.

United Gas Improvement Co.,
Philadelphia Gas Works.
Distribution Dept.

Ill. No. 17.

Chain Hook for Tapping Large Mains.

The object of this hook is to save the necessity of excavating under a large main for the purpose of attaching the tapping device. The hook can be forced under the main and adjusted as shown.

United Gas Improvement Co.,
Philadelphia Gas Works.
Distribution Dept.

Ill., No. 18.

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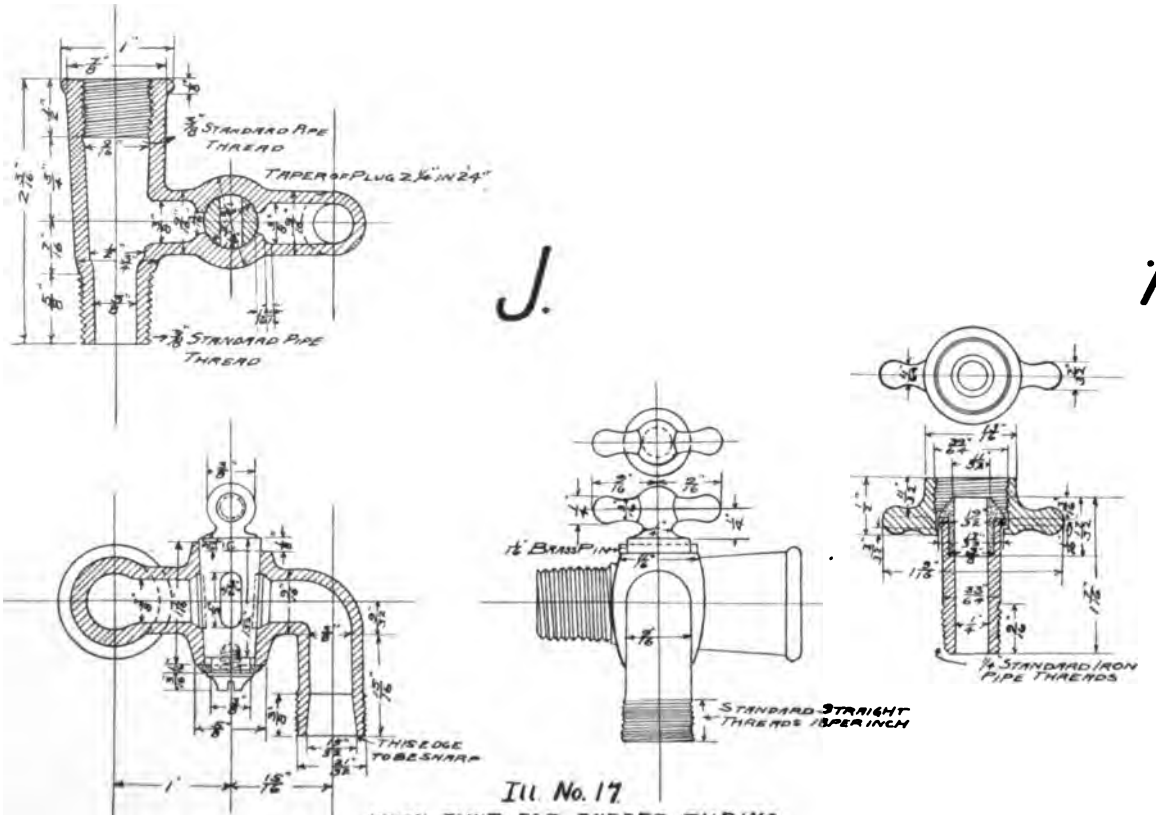
J.
H
3/8" STANDARD PIPE THREAD
TAPER OF PLUG 2 1/16" IN 24"
3/8" STANDARD PIPE THREAD
1/4" BRASS PIN
THIS EDGE TO BE SHARP
STANDARD STRAIGHT THREADS 18 PER INCH
1/2 STANDARD IRON PIPE THREADS

Ill No. 17
UNION JOINT FOR RUBBER TUBING.

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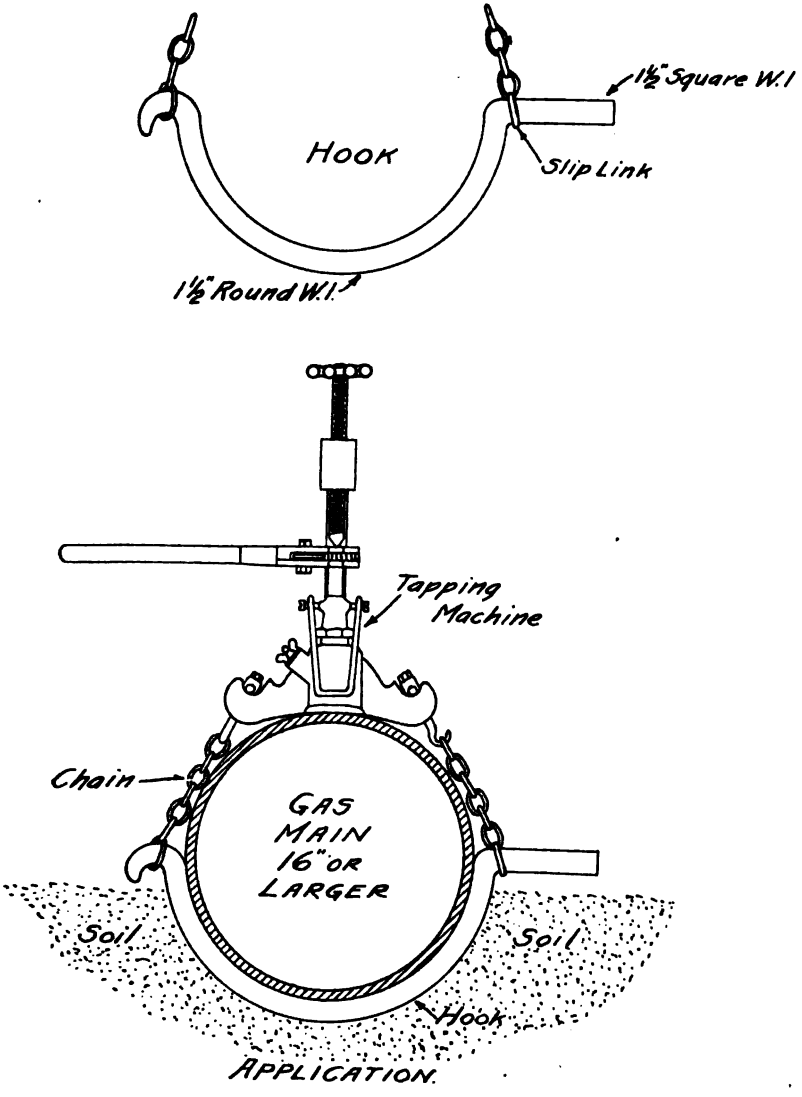
Ill No. 18

CHAIN HOOK FOR USE IN TAPPING LARGE MAINS - 16" AND OVER.



APPLICATION.

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Street Leak Drill.

This drill is used for boring leak holes, instead of driving a bar. The object is to prevent entering and injuring terra cotta or metal conduits, containing electric wires. The pavement and pavement foundation are pierced by driving a bar, which is then removed, and the leak drill is then used in piercing the earth to the required depth. If the drill chokes with earth, it is pulled out, cleaned, and again inserted. In hard soil the drill should be operated by three men, one bearing his weight directly over the centre, and one at each end of the handle rotating it.

United Gas Improvement Co.,
Philadelphia Gas Works.
Ill. No. 19. Distribution Dept.

Lather Pot for Complaint Men.

This is a tin bottle similar in shape to a talcum powder bottle, with a brush like a shaving brush soldered to the metallic lid.

United Gas Improvement Co.,
Philadelphia Gas Works.
Ill. No. 20. Distribution Dept.

Service Cleaning Device.

By the use of this device it is safe for one man to blow out or clean out a service. Without the device, it is not safe for this work to be done by one man alone. In using the device, the gas is first shut off at the curb cock; then the plug at the head of the service is removed and the device attached. By the proper manipulation of the two cocks, the man can blow out a service, or blow wood alcohol, or oil, into it without the necessity of any gas escaping into the cellar. By the use of the plug with small hole, a wire can be pushed into the service with a very small escape of gas. Before the device is removed from the head of the service, the curb cock is again shut.

United Gas Improvement Co.,
Philadelphia Gas Works.
Ill. No. 21. Distribution Dept.

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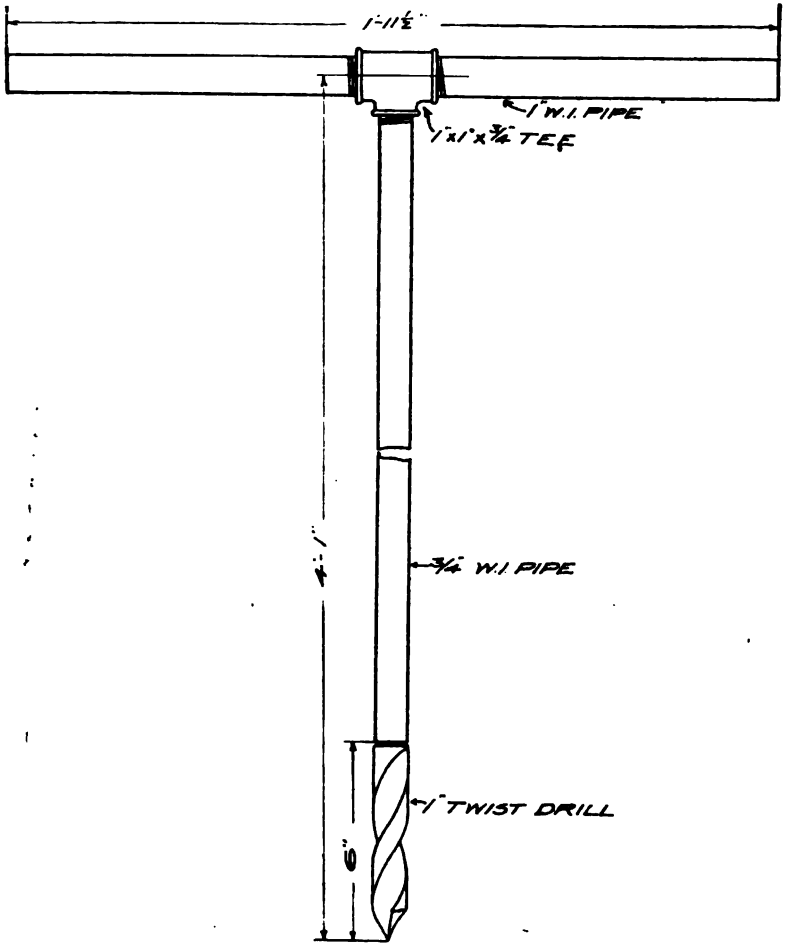

STREET LEAK DRILL.

Ill. No. 19.

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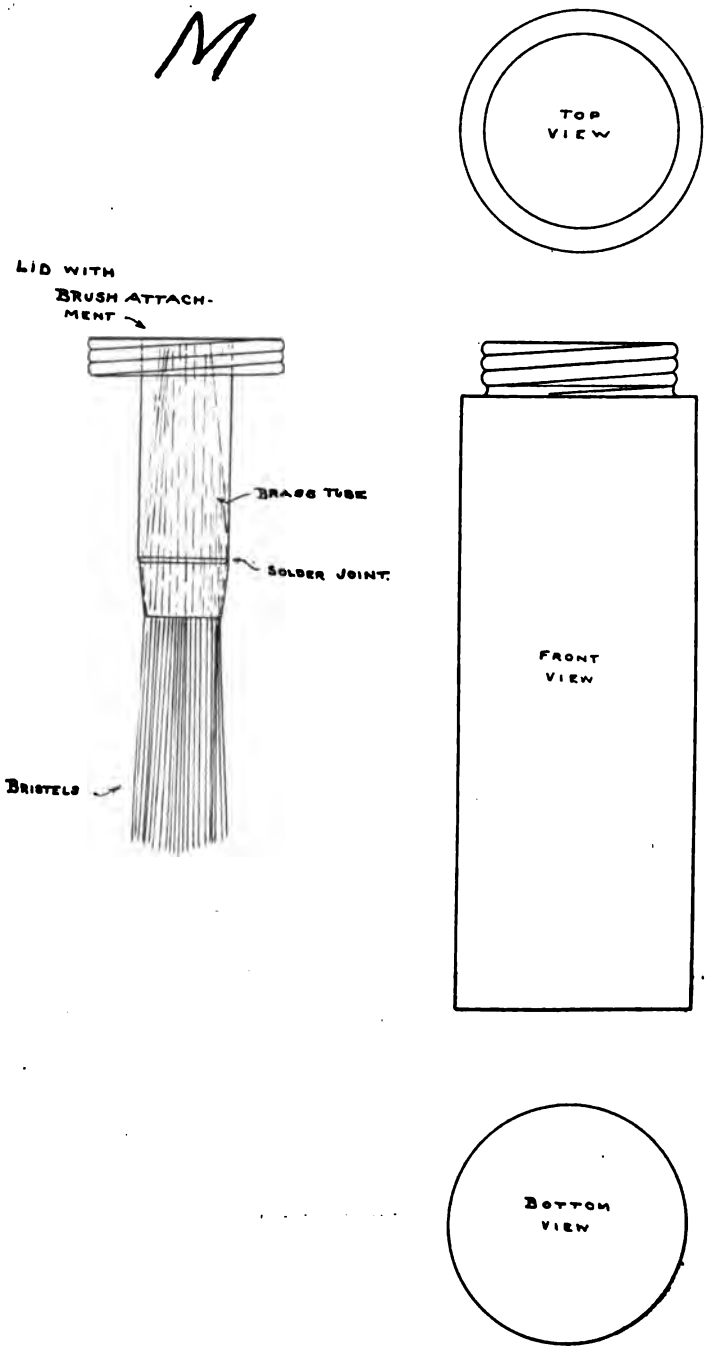

Ill. No. 20—Lather Pot for Complaint Men.

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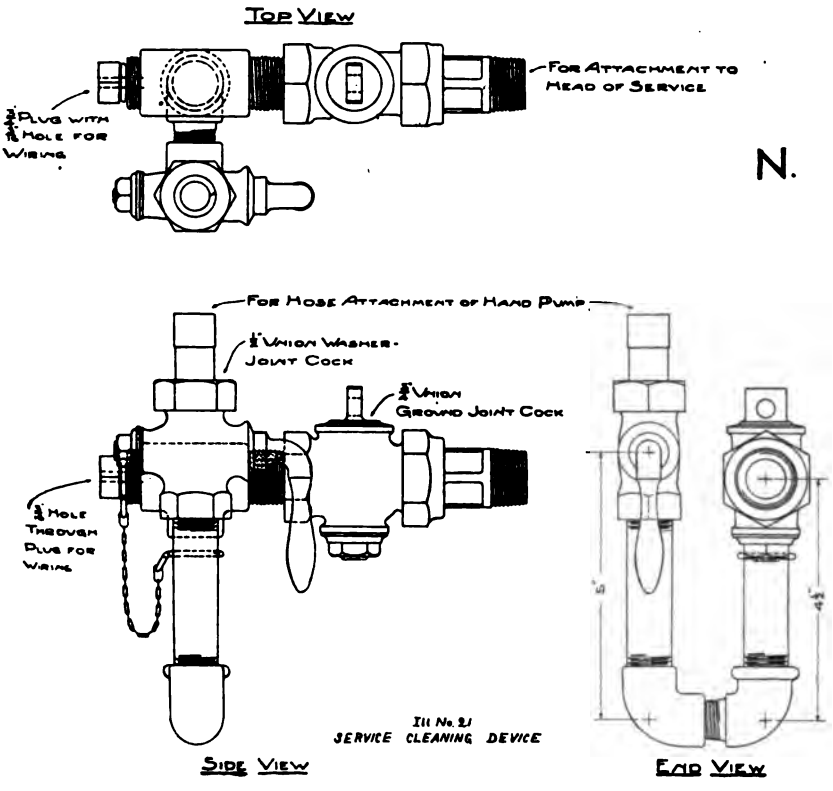

Work Completion Schedule.

A valuable addition to the ordinary form of consumers' record in facilitating the completion of work is the Work Completion Schedule. Each work card, on its way to the fitting department, is stamped by the clerk at the consumer's record with a date, or hour, before which it must be completed. The clerk places a dummy, or finder card, in the consumer's record, so that if the work card so stamped has not returned to him from the fitting department before the date for which it is scheduled, he starts an inquiry for the same. As soon as the work of the previous day is entered on the consumer's record, the clerk goes over the record, canvassing the same for all overdue work. The clerk is, of course, provided with a previ-

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ously arranged schedule of the number of days, or hours, that is permitted for different classes of orders. The existence of a date on each work card is found to be very effective in spurring on the workmen in the fitting department. The use of the method here described has been found valuable in bettering the service rendered to consumers on all classes of work.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works.
Distribution Dept.

CORRESPONDENCE METHODS.

In offices where it is the practice to retain a carbon copy of letters sent out, attaching the same for file to the letter which is answered, the carbon copy should be made on the back of the letter which is answered. This saves paper, saves room in the file, and prevents any possibility of a letter and its answer getting separated. Of course, there are occasions when this practice cannot be used, but so far as it is applicable it is of value.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas. Works.
Distribution Dept.

KNIFE FOR TOPPING METERS.

This "wrinkle" consists of a two-edged knife instead of the ordinary form with one edge. This enables the operator to follow the soldering iron in either direction without turning the knife, and thus quickens the removal of the top from the meter.

UNITED GAS IMPROVEMENT CO.,
Philadelphia Gas Works.
Distribution Dept.

Ill. No. 22.

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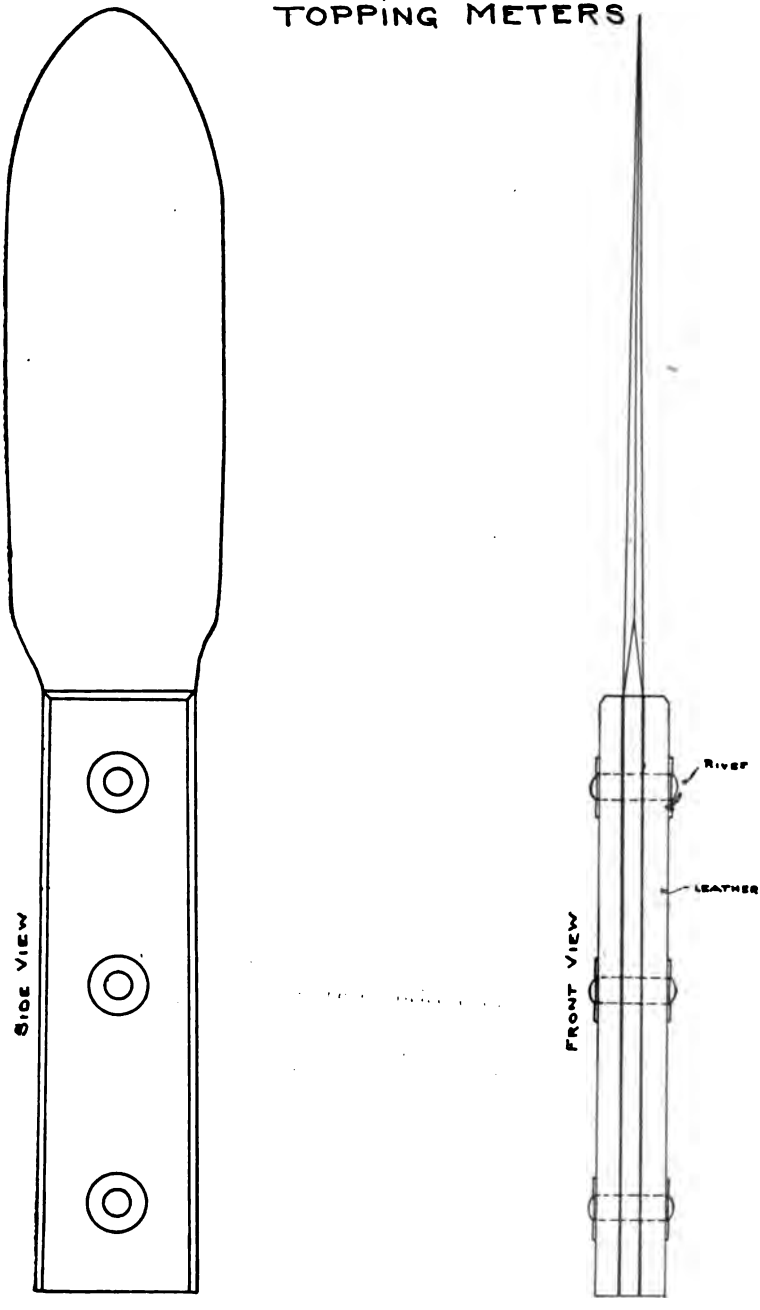
KNIFE FOR
TOPPING METERS



Ill. No. 22.

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Meter Repairers Soap Cup.

The advantages of this cup are the two compartments, the upper one for soap and the lower one for water. The drippings from the soap pass through the perforations and drop into the water. The use of this cup results in a saving of soap and the maintenance of a uniform quality of light soapsuds. The cup is used in shops where meters are tested and repaired, the soapsuds being required to determine and locate leakage on the meters.

United Gas Improvement Co.,
Philadelphia Gas Works.
Distribution Dept.

Ill. No. 23.

Device for Cleaning Holder Rivets.

The tool is made with three prongs so shaped as to fit the rivets closely. The edges are ground sharp. The tool may be inserted in a spiral screw driver when one stroke is sufficient to clean the rivet nicely.

E. P. Gartland,
Denver (Col.) Gas & Electric Co.

Ill. No. 24.

Re-Tapping Stopper.

This is a stopper for use in re-tapping mains. The stopper is inserted and put in place and the enlarged hole can then be chiseled out until the right size for the reamer.

C. L. Day,
Peoples Gas Light Co., Chicago.

Ill. No. 25.

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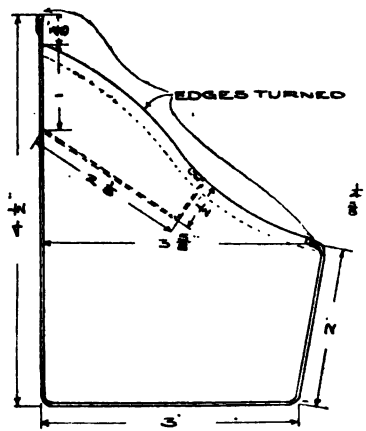
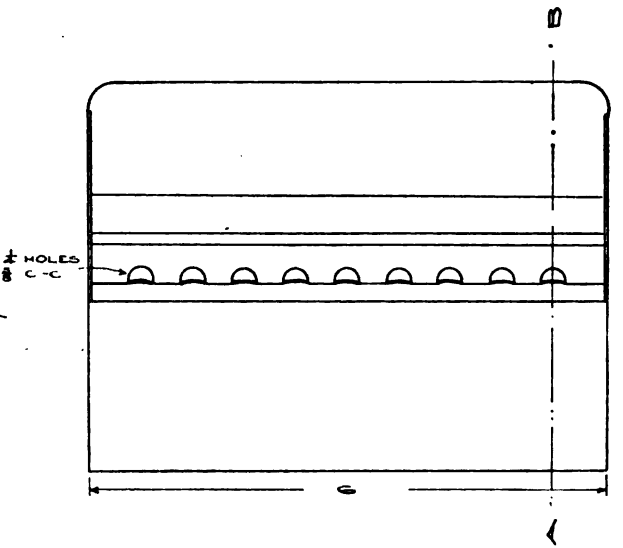
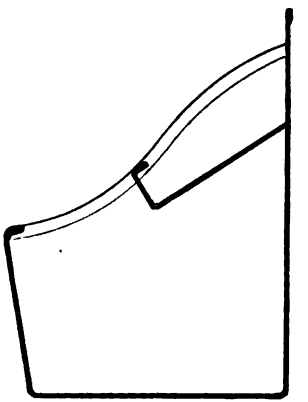
P







SECTION ON A-B.

Ill. No. 23.
SOAP CUP

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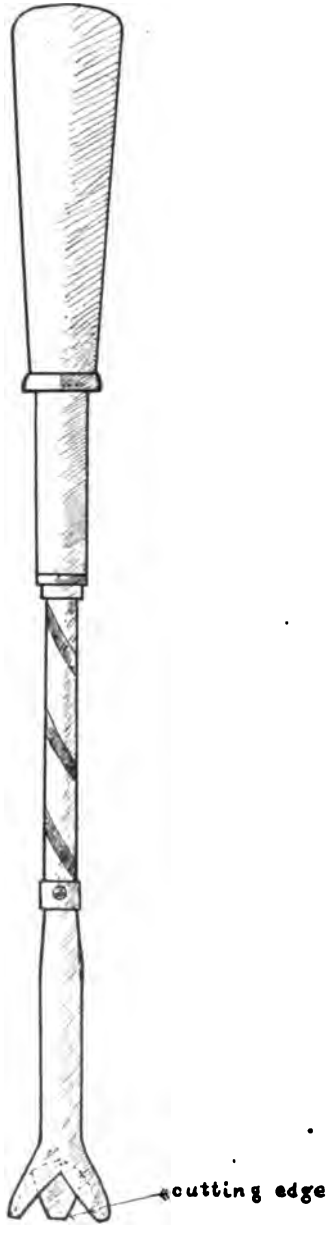

Ill. No. 24—Device for Cleaning Holder Rivets.

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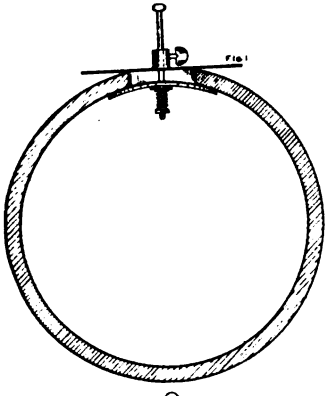

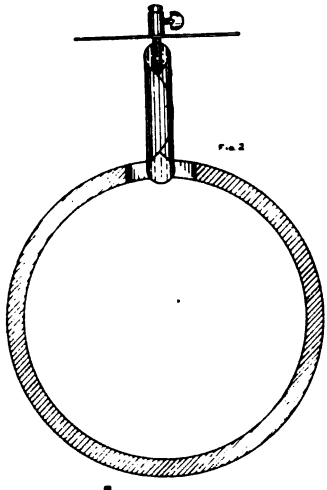

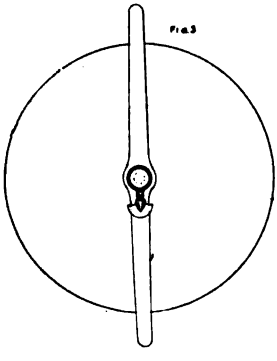

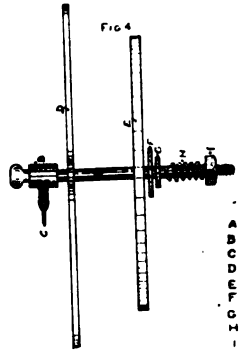

INDEX
A STEM
B COLLAR
C SET SCREW
D STEEL BAR
E RAINBOW PACKING WASHER
F
G STEEL WASHER
H BRASS SPRING
I NUT

In A1
RETAPPING STOPPER

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Decorative Gas Arch at Fredericksburg, Md.

The accompanying photographs show a novel design for decorative lighting with gas. This arch was afterwards remodeled by placing a gas sign, "Cook with Gas," in place of the arc lamps.

R. C. Congdon, Mgr.,
Atlanta (Ga.) Gas Light Co.

Ills. Nos. 26(a)—26(b).

Tabulation of Discharge Through a Two-Inch Diameter Diaphragm.

Several years ago Mr. McDonald, of Louisville, gave the results obtained by using a diaphragm with a small orifice in measuring the output of his plant. In order to obtain a set of figures for daily use a one-sixteenth inch thick diaphragm with a two inch diameter hole was inserted in the outlet of a relief holder. A U gauge was connected up to openings drilled about a foot and one-half on each side of the diaphragm, and scale attached which could be read to tenths of an inch. Repeated observations were made on the flow at from one-half to three inches differential pressure, 20,000 feet of gas being used for each observation, the final results being the average number of readings. These results were plotted and a curve drawn, which was extended up to eight inches by using the figures already obtained together with the usual formula.

The following table gives the flow in cubic feet per hour of one opening. Should continuous readings be desired, a recording gauge could be used. Additional holes should be used whenever the loss of pressure becomes too great.

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Ill. No. 26A—Decorative Gas Arch at Fredericksburg, Md. [Day View].

Digitized by Google

Ill. No. 26B—Decorative Gas Arch at Fredericksburg, Md. [Night View].

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Tenths Inches	Cu. Ft. per Hr.	Tenths Inches	Cu. Ft. per Hr.
10	4500	50	10000
1	4700	1	10100
2	5000	2	10200
3	5200	3	10300
4	5400	4	10400
5	5500	5	10500
6	5700	6	10600
7	5900	7	10700
8	6000	8	10800
9	6200	9	10900
20	6400	60	11000
1	6600	1	11100
2	6700	2	11200
3	6800	3	11300
4	7000	4	11400
5	7100	5	11500
6	7200	6	11600
7	7400	7	11700
8	7500	8	11800
9	7600	9	11900
30	7800	70	11900
1	7900	1	12000
2	8000	2	12100
3	8100	3	12200
4	8300	4	12300
5	8400	5	12400
6	8500	6	12400
7	8600	7	12500
8	8700	8	12600
9	8900	9	12700
40	9000	80	12800
1	9100		
2	9200		
3	9300		
4	9400		
5	9500		
6	9600		
7	9700		
8	9800		
9	9900		

Nearest even hundreds used.

C. W. ANDREWS,
Zenith Furnace Co.,
Duluth, Minn.

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Arrangement for Hanging Arcs.

This plan consists in a pair of swing joints so that the lamp may be lowered for cleaning and maintenance.

Geo. W. Thomson,
Suburban Gas Co., Chester, Pa.

Ill. No. 27.

Portable Outfit for Testing Large Mains.

The outfit consists of a 12 H. P. gasoline engine belted to an air compressor; the whole outfit, including truck, is about 4½ tons.

C. L. Day,
Peoples Gas Light and Coke Co., Chicago, Ill.

Ill. No. 28.

Industrial Installation for Melting Wax.

This installation consists of a water heater and piping system for melting wax in lithographic and similar establishments.

F. C. Shepard,
Minneapolis Gas Light Co.

Ill. No. 29.

Industrial Installation for Melting Glue for Sash and Door Factories.

This installation consists of water heater and piping system as shown in the accompanying photograph.

F. C. Shepard,
Minneapolis Gas Light Co.

Ill. No. 30.

Method of Supporting Service Pipes.

The object of this plan is to support service pipes while a trench is open or after back filling, in order to prevent trapping the pipe.

Geo. Beadenkopf,
Consolidated Gas, Electric Light & Power Co.,
Baltimore, Maryland.

Ill. No. 31.

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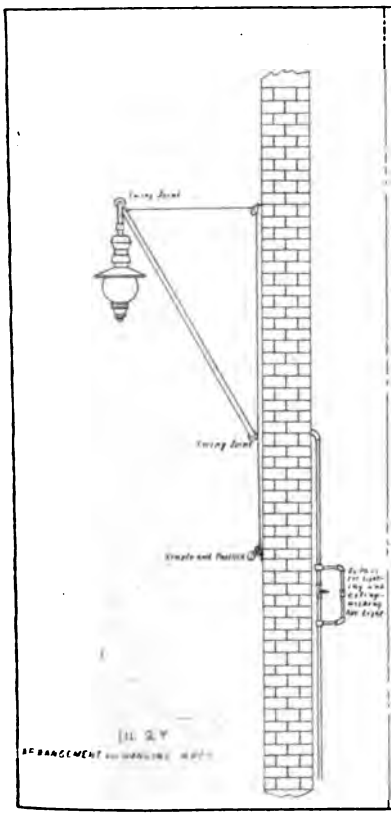

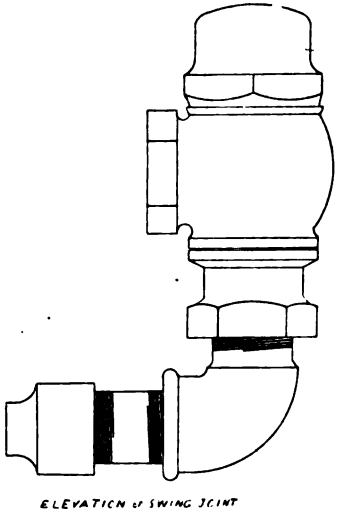

ELEVATION of SWING JOINT

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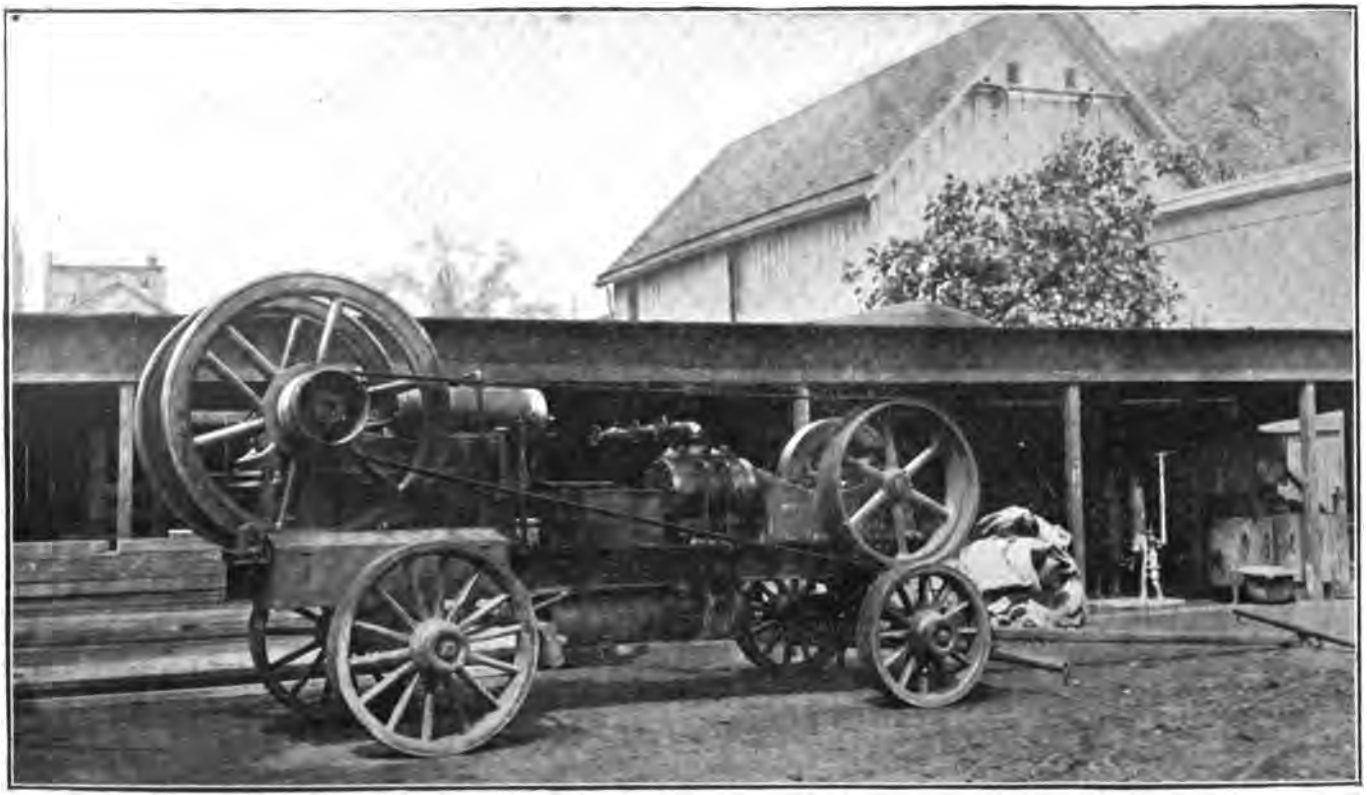

Ill. No. 28—Portable Outfit for Testing Large Mains.

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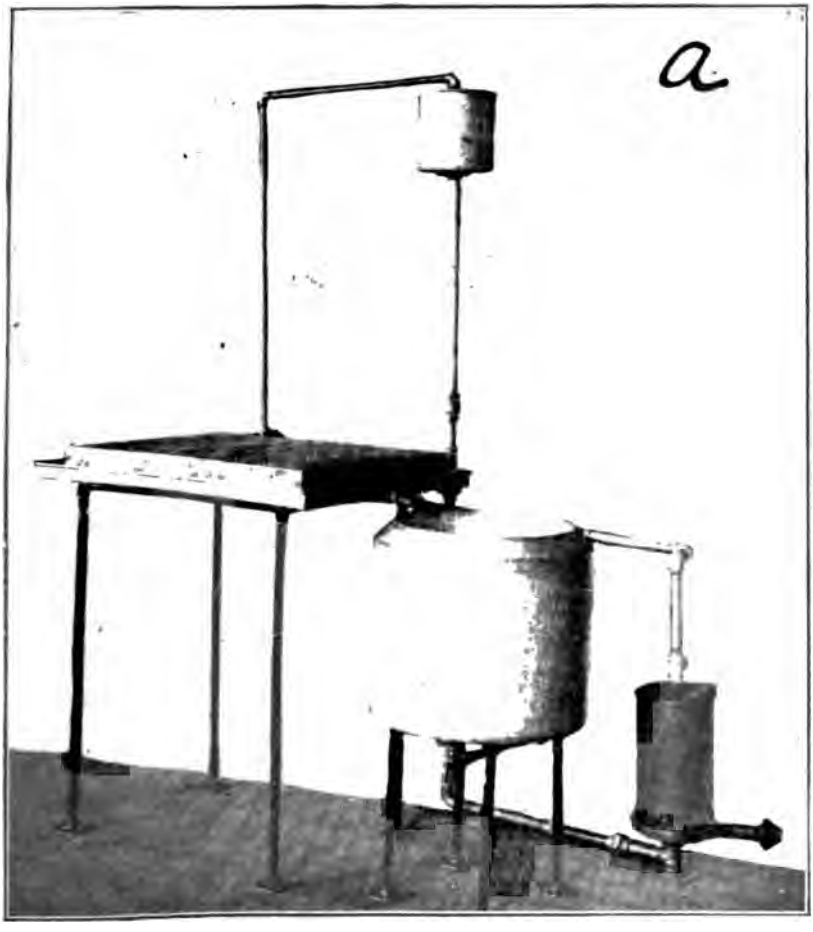

Ill. No. 29.—Installation for Melting Wax in Lithographic Establishments.

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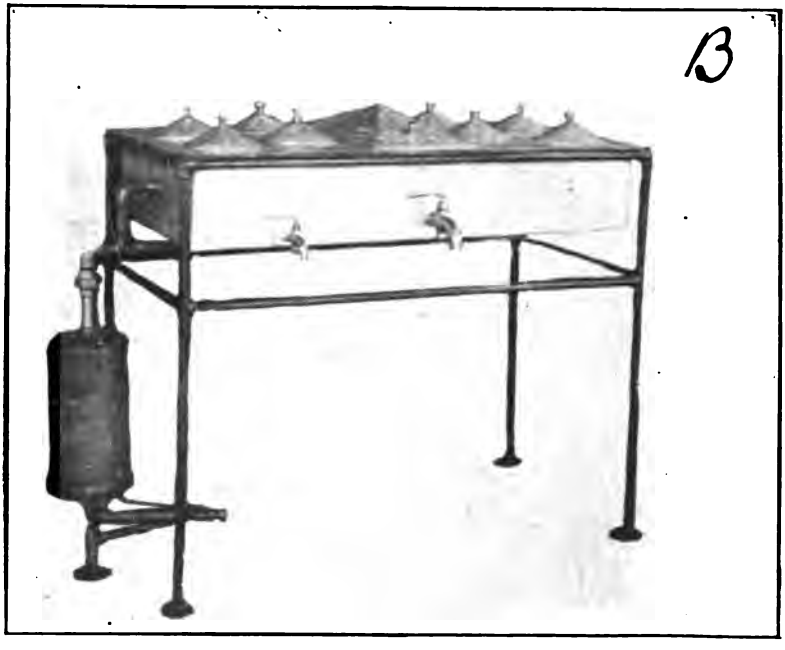

Ill. No. 30—Installation for Melting Glue in Sash and Door Factories.

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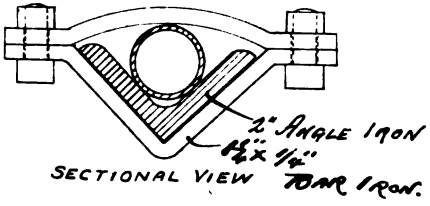
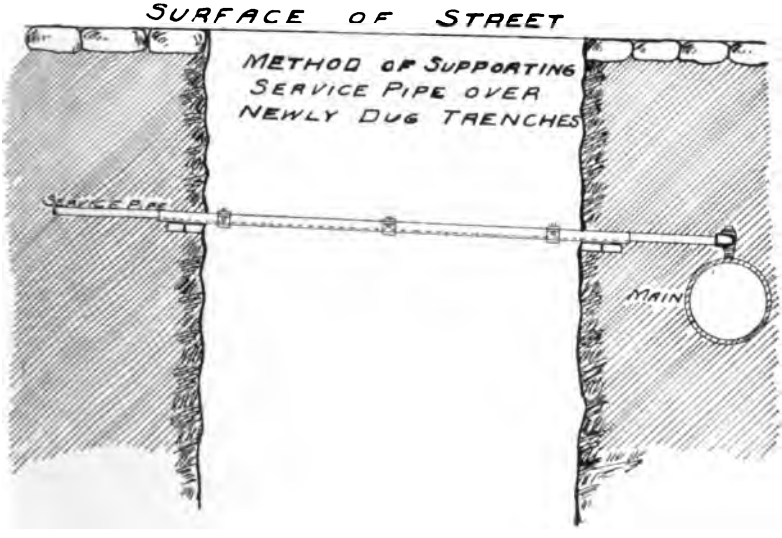


Ill No. 31



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Test Plug for Main Testing.

This plan is to use the ordinary soil pipe plug used by plumbers which has an expanding rubber ring. It is simpler to handle than the ordinary cast-iron plug, which must be put in with rope.

Geo. Beadenkopf,
Consolidated Gas, Electric Light & Power Co.,
Baltimore, Maryland.

Ill. No. 32.

Display Room Fixtures.

One is a revolving post for displaying gas brackets, and the other a series of swinging shelves for displaying hot plates and small burners. They are both designed to minimize space required.

Vernon K. Gould,
Bangor (Me.) Gas Light Co.

Ill. No. 33.

Lead Pipe Cutter.

The accompanying sketch shows the plan of a hand operated lead cutter that has the advantage of great capacity and also does not flatten the pipe at point of cut, as the knife is very thin and sharp. The reel is arranged with four spokes, on one side shorter than the four on the other side, so that after removing the reel a coil of lead pipe can be slipped over the four short spokes.

C. L. Day,
Peoples Gas Light and Coke Co., Chicago, Ill.

Ill. No. 35.

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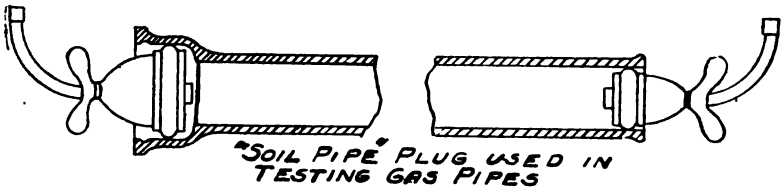

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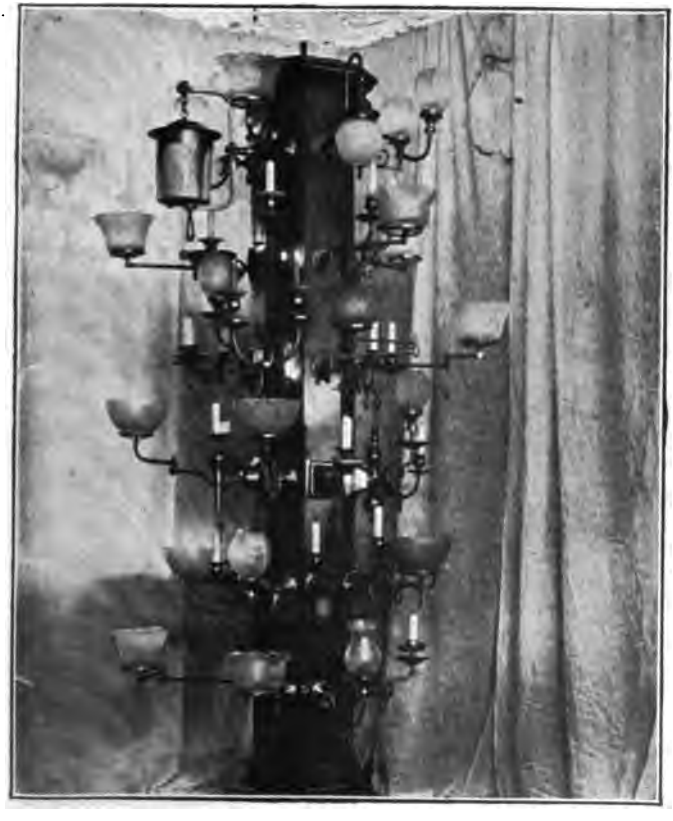

Ill. No. 33—Revolving Post for Displaying Gas Brackets.

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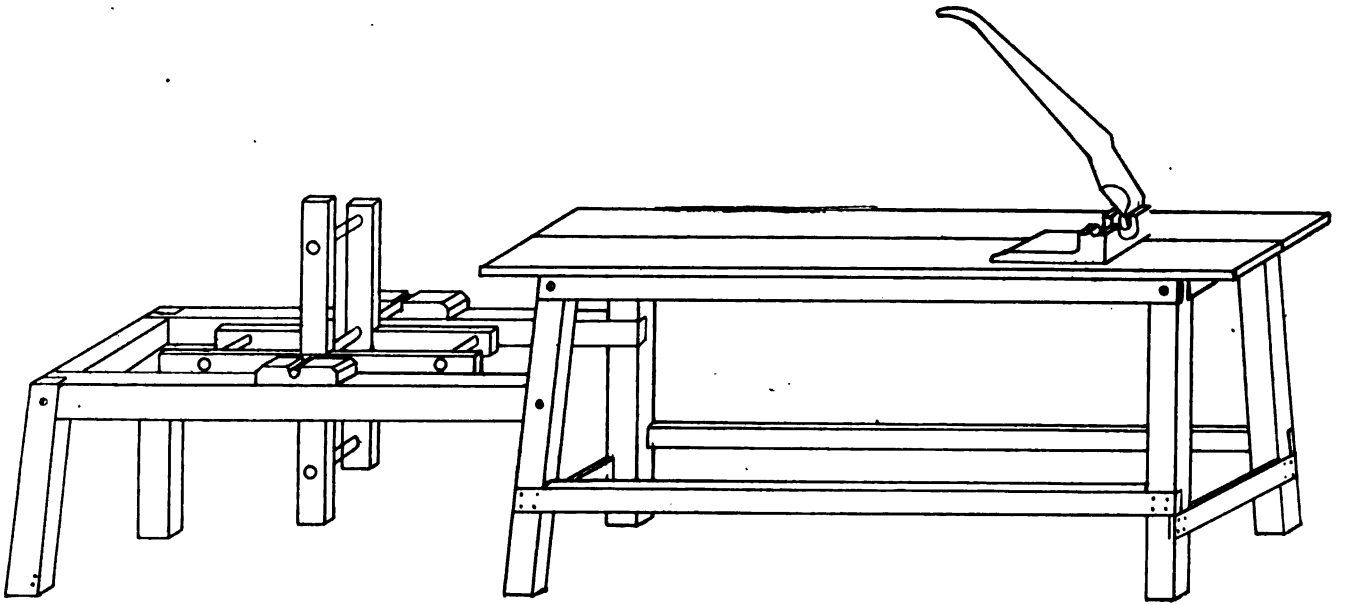

Ill. No. 35
LEAD PIPE CUTTER

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Pipe Testing Rack.

When laying a 12 inch wrought iron high pressure line in Chicago, leaks were found after putting a pressure of 60 pounds per square inch on the line. The expense was considerable in locating the leak, and in removing and replacing the imperfect pipe, and at the same time the work was delayed.

In order to discover imperfect lengths before the pipe was placed in the trench, an apparatus was constructed (shown in accompanying sketch) to test each length separately. It consists of two iron caps connected by two iron bars, which are drilled so that, by placing pins in the holes behind the forged cross bar, it may be used on different lengths of pipe.

A piece of ¾ inch sheet rubber is fitted into each cap, and after the caps are screwed up tight the length is pumped up to 10 pounds per square inch pressure by means of a hand pump attached to a pipe leading from a tap hole in one of the caps, and on which is placed a steam gauge. The pressure is left on for a couple of minutes while the men go over the seam of the pipe with soapsuds.

C. L. Day.
General Superintendent of Street Department,
The Peoples Gas Light & Coke Company,
Chicago, Illinois.

Ill. No. 36.

Emergency Pipettes.

The scheme shown in the accompanying sketch has been found very useful in replacing broken pipettes for either Tuttle or Orsat gas analysis sets. It often enables the completion of work that would be spoiled by the delay necessary to secure a new pipette.

R. G. Griswold,
Denver Gas & Electric Co.

Ill. No. 37.

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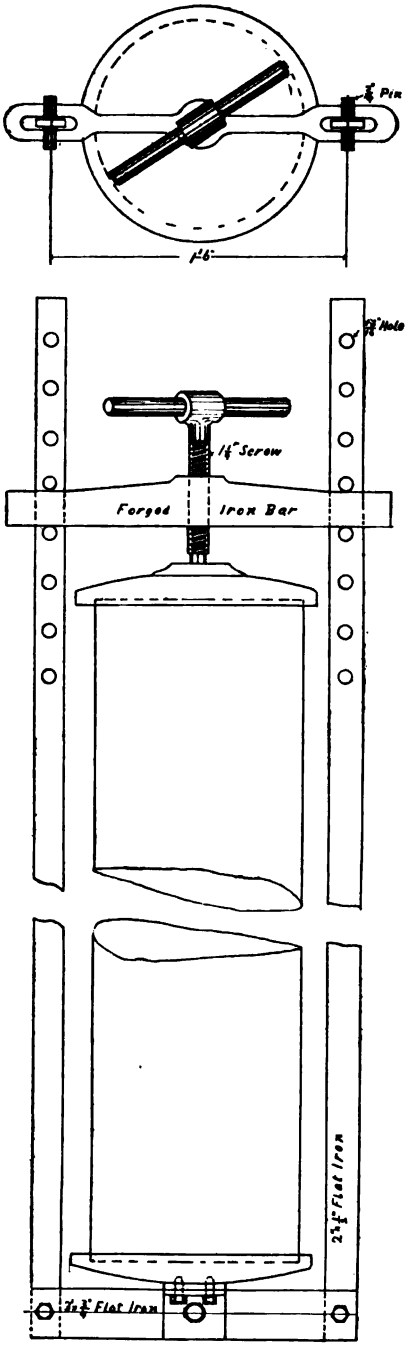

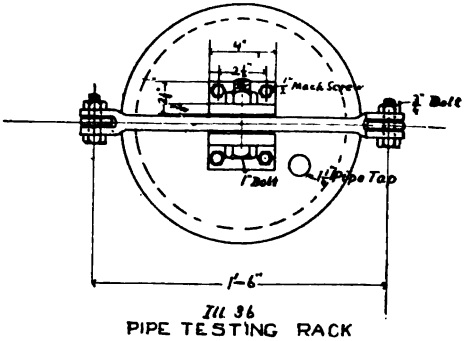

Ill 36
PIPE TESTING RACK

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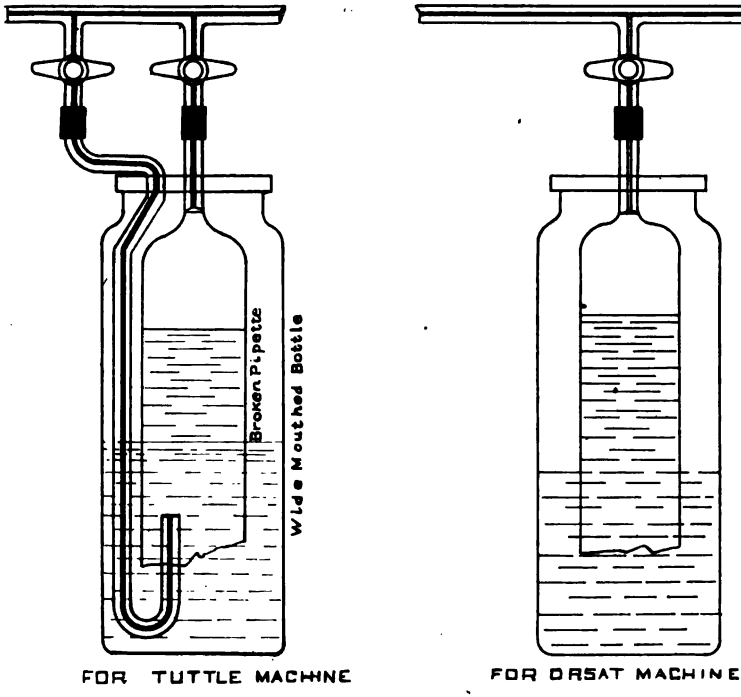

IIL No. 37

EMERGENCY PIPETTES

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Automatic Hydraulic Main Tar and Liquor Overflow.

A cast iron box like sketch is attached to end of hydraulic main. Openings for liquor and tar are cut in end plate of hydraulic main opposite openings in overflow box. The level is maintained by couplings, attached to 4-inch pipe, which may be regulated by stem and yoke. The tar overflow is operated the same as liquor overflow, but owing to the difference in specific gravities of tar and ammonia, the tar overflow is from 2 to 3 inches lower than liquor overflow.

A small stream of tar and liquor is constantly running from overflows. The tar coming away from hydraulic constantly does not become thick and pitchy.

H. E. Mann,
Cleveland Gas Light & Coke Co.

Ill. No. 38.

Damper Valve for Street Mains.

This valve is used for partially closing off gas feeder mains in certain districts of high pressures in order to use enough pressure on the trunk mains to give good service in outlying poor pressure districts. In the average case it can be set for the load conditions and run without attention for some time.

Chas. S. Beardslee,
Cleveland Gas Light & Coke Co.

Ill. No. 40.

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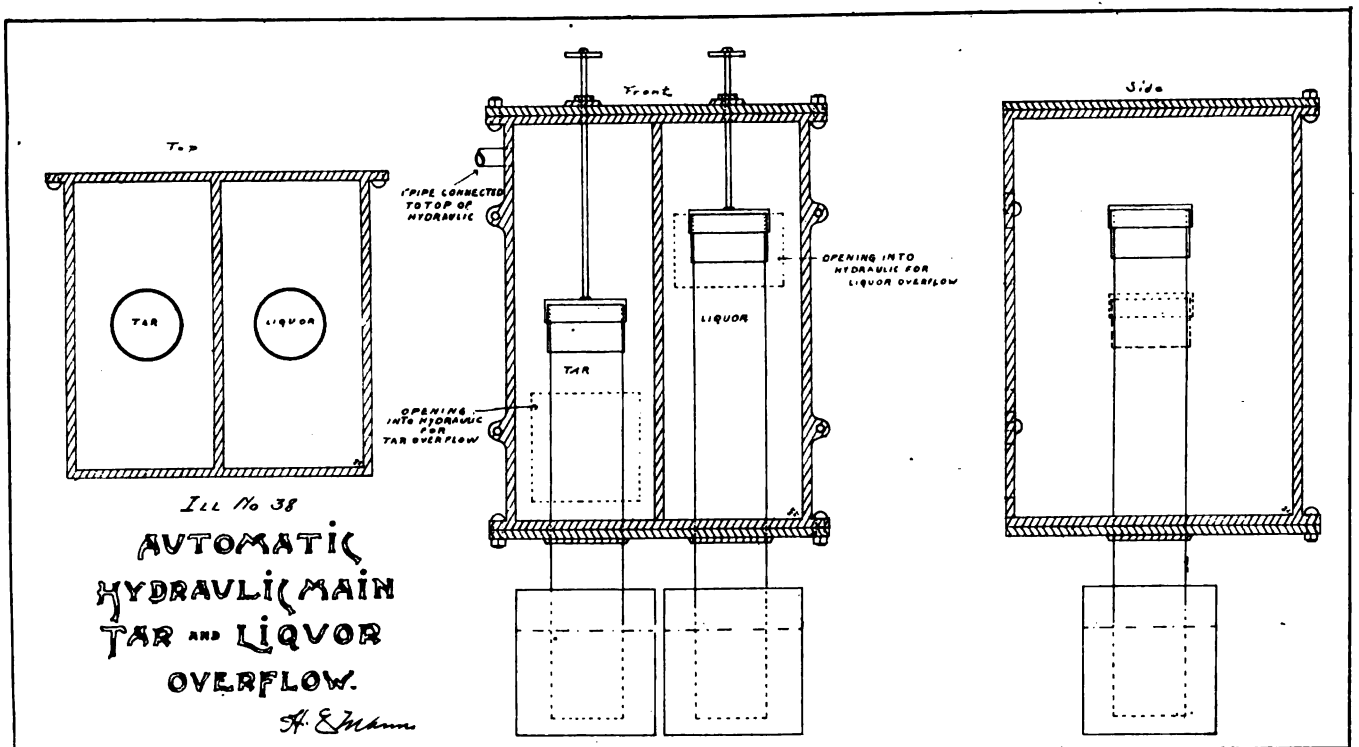

Ill No 38

AUTOMATIC HYDRAULIC MAIN TAR AND LIQUOR OVERFLOW.

H. E. Adams

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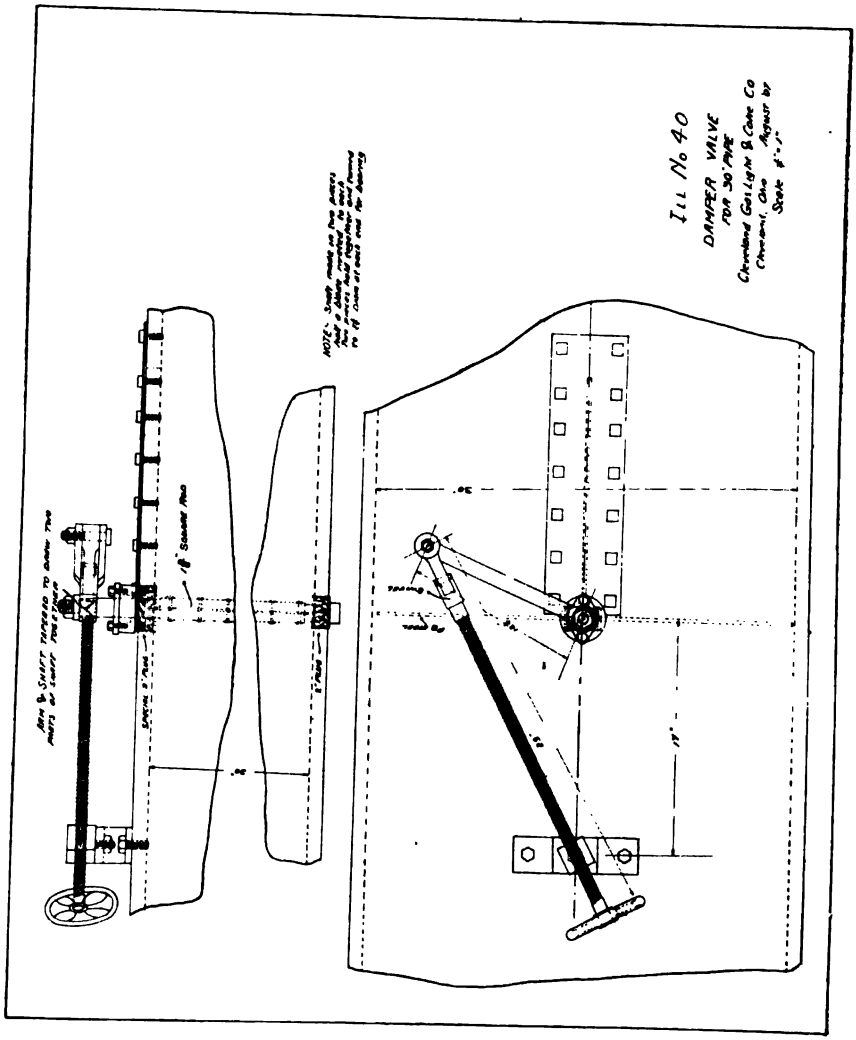

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The following wrinkles were compiled by the editor from various bulletins and letters of instruction to operators, written by Mr. Henry L. Doherty.

Method of Improving Workmanship of Fitters and Meter Men.

"A good plan of improving the service of these departments is to have a bulletin board in the shops and post daily and monthly the number of orders executed by, and the number and nature of mistakes and faults found in the work of each man, and endeavor to instill a rivalry between the different men in making a record for quantity and quality of work done."

Using Large Meter as Test Meter in Laboratories.

"A very handy arrangement for use in laboratory or other test work consists in extending the test dial of a 20 light meter and putting on a large needle of six or eight inches diameter. The dial for this needle should be made of glass so that the other dials can be read and a rubber band should be lightly stretched from the extended shaft to the edge of the dial to prevent any back lash caused by the large needle. This meter is very satisfactory for any work except refined chemical work, for which an aspirator or wet meter should be used."
Ill. No. 50.

Method of Clearing Gas Filled Vessels.

"Whenever it becomes necessary to open chambers filled with gas where there might be danger of explosion, a very good method is to clear the chamber with steam and after opening and cleaning or repairing, to again clear the chamber out thoroughly with steam and then turn in the gas. The steam condenses and leaves the chamber full of gas. Care should be taken to leave the steam on long enough to allow the chamber to become thoroughly heated to prevent too sudden condensation of the steam."

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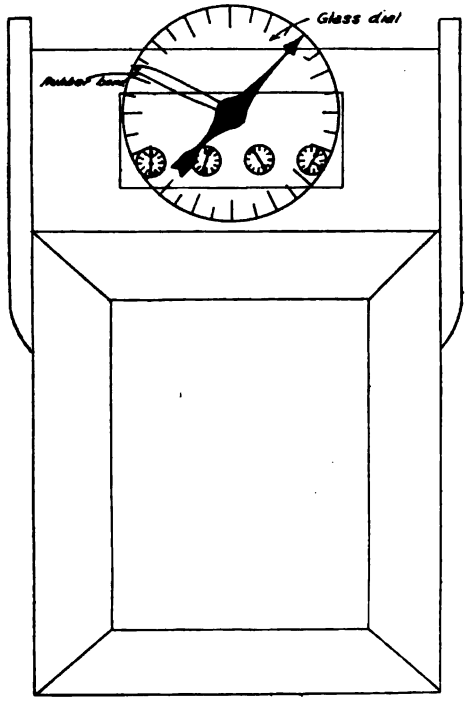

Ill. No. 50—Large Meter for Test Meter.

METHOD OF CLEARING GAS HOLDERS BEFORE TURNING IN GAS.

"In order to prevent all danger to a gas holder before putting it into service the following plan could be followed: Pass waste flue gas from the benches into the holder and dilute the atmosphere until the relative amount of oxygen is very small, and then turn in the gas. There is then no danger of forming an explosive mixture which, if ignited, might wreck the holder. In the case of large holders or holders remote from the works, a good plan is to build a temporary furnace for obtaining the necessary flue products or to connect a gas burner of large capacity and pass the flue products through the holder until the air is replaced by them."

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Means of Cheaply Increasing the Capacity of Existing Distributing Systems.

"When at Columbus, Ohio, we had an unexpected and a severe lack of gas supply at the eastern extremity of the city. This shortage was not noticed until the frost had sunk deep into the ground. All of the available routes for a new gas main were paved. Our large main led out East Broad street under a beautiful asphalt street, which the city would not permit to be opened for a continuous ditch. I think this main was 16 inches in diameter. I proposed to Mr. Butterworth that we open this street at each block and insert a 4 inch steel main inside the 16 inch main, and by the use of suitable pressure regulators at suitable points, we would empty the gas from the 4 inch main into the 16 inch main, carrying whatever pressure on the 4 inch main which was necessary to yield sufficient conductivity to maintain our pressure, say, up to 60 lbs. per square inch. This plan is open to the following objections:

1st. Reduction of capacity of the 16 inch pipe.

2d. Depreciation of candle power, due to compression and high velocity of flow in 4 inch pipe.

3d. Power required.

4th. Low capacity of high pressure pipe if flow is no greater than a square root of the pressure.

The plan has the following advantages:

1st. Prevents tearing up streets for continuous ditch.

2d. Can be installed quickly and cheaply.

3d. Leakage from high pressure main will simply escape into low pressure main.

4th. Permits high conductivity with good pressure regulation."

Scheme for Determining Leakage in Recuperator Flues of Gas Benches.

"The low temperature of gases leaving the stack of a gas bench can only be explained by leakage of air from the secondary flue to the waste gas flue. This leakage is a foe to good heats and economy.

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"Suppose leakage does occur, the flow will be from point of greater pressure to point of lesser pressure, and as exhaust flues must have the lesser pressure, the secondary air will flow to the exhaust flues. This has a deterring effect in two ways: First, some of the heat absorbed in the secondary flues is lost because some of the secondary air is lost, and, second, this air dilutes and lessens the temperature in the exhaust flue, and the differential temperature between the secondary flue and the exhaust flue is thereby lessened and heat is transferred to the secondary air met further down.

"To lessen this leakage use stack damper to yield least possible difference between the secondary and exhaust flue. To determine extent and approximate location of this leakage, make flue gas analysis at point flue gases enter recuperator flues and test at each flue going down. The increase of O plus $O \times 3.34\ N$ = leakage, and the increase of O represents leakage at each flue.

A heat balance can be worked out from this and the loss due to leaky flues approximated. Sometimes leaks in flues can be plastered up, resulting in better heats and less fuel consumption."

Oil Piping System for Cold Climates.

"In order to secure good oil circulation in cold weather, the following has proven satisfactory. Insert a ⅛ inch pipe inside the oil pipe and when too cold for the oil to flow freely turn steam into the small pipe. Care must be taken to have the piping drain to the pump in this case in order to prevent any vaporization of the light oils from shutting off the pump. By means of this plan oil can easily be kept flowing in exposed piping in coldest weather."

Screen for Protection of Blast Piping.

"The method consists of the installation of a diagonal or conical screen of large area in the blast piping which will prevent ignition in the piping back of the screen. The screen

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is made diagonal or conical in order to give a large area and cause as little back pressure as possible. Figure 1 shows diagonal screen in square box inserted in blast line, and Fig. 2 the conical screen in the blast pipe."

Ill. No. 47.

METHOD OF MAKING ROUND SCRUBBER TRAYS.

"Make a semi-circular form and make the trays in two or four sections, as desired. This method has the advantage of being simple and quick. The only sawing to be done is a straight cut instead of a circular cut as ordinarily made. It also enables assembling the trays with a very small waste of material, which is a considerable item where hard wood is used."

Ill. No. 48.

METHOD OF USING CANVAS IN MAKING SCRUBBER TRAYS.

"The plan shown on the accompanying sketch shows a simple, cheap method of making scrubber trays. It is also effective for placing a large amount of surface in the scrubbers, being thinner than the box boards ordinarily used. The plan is to assemble the trays in sections, taking care to keep the canvas tight when wet. Boards are inserted every fifth or sixth row to make the trays stiff and keep them in shape. The canvas can be wound around the cleats and each piece cut to fill the section between the wooden braces."

Ill. No. 49.

DEODORIZING FOUL LIME IN PURIFIERS.

"In order to overcome the extremely offensive odor about the works when lime purifiers are being changed, I suggest that the boxes be connected to the waste flues from the benches or boilers and the lime carbonated before the box is opened. The outlet of these gases from the box should be into the chimney of the boiler plant, which will take them up into the air and dissipate them. When the lime is thoroughly carbonated it can be removed without trouble, and, if desired, it could be dried until caked enough to handle in lumps by admitting the flue gases hot."

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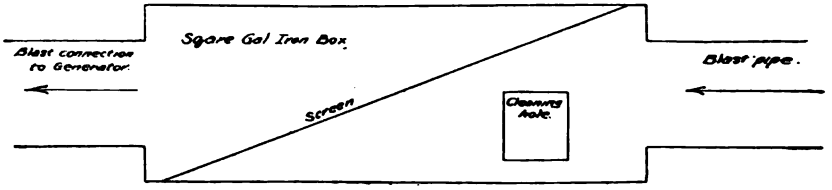


Fig. 1.

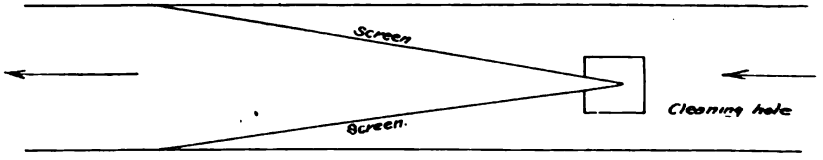
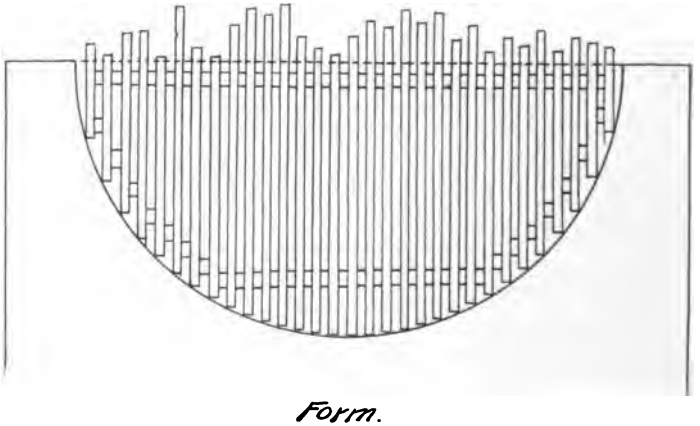


Fig. 2.

Ill. No. 47—Screen for Protection of Blast Piping.



Form.

Ill. No. 48—Method of Making Round Scrubber Trays.

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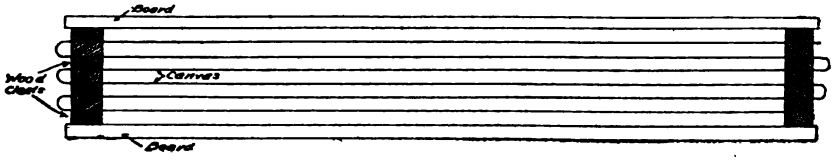

Ill. No. 49—Method of Using Canvas in Making Scrubber Trays.

Scheme for Heating Seal Box and Scrubber When Starting Water Gas Plant.

"In small water gas plants where the machines are run only a few hours each day there is a considerable loss in cold weather, due to the seal box being cold and not getting into normal operating condition until quite a number of runs have been made, there being a considerable loss in candle power during these runs. In order to have the seal and scrubber in good condition before starting the runs, I suggest that a blow-off be installed on the outlet of the scrubber and that after the machines have been heated up to normal, the blast be passed through the seal and scrubber for a few minutes before starting the first run."

Determination of Lowest Permissible Pressure on Hydraulic Main.

"In order to secure best operating results the pressure in the hydraulic main should be no more than necessary to prevent drawing in of furnace gases. In order to arrive at the proper pressure, the following method should be employed: Starting at the pressures now being carried on your hydraulic main, make a number of tests on the gas for CO_2 and O. Then reduce the pressure one-tenth for several hours and repeat the tests. This should be continued until the tests begin to show some increase in CO_2 and O. Then if the hydraulic main is in sections, tests should be made to determine whether the seals are being drawn on any special section, and if possible the leak traced to a certain standpipe, which, if defective, should be repaired. After getting the house in as good uniform

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condition as possible, the seal should be increased one-quarter to one-half inch above the point where leakage shows and maintained at that point, and the vacuum drawn by the exhausters should be readjusted whenever operating conditions are changed."

Drafting Board for Copying Drawing Prints.

"It is often desired to copy blue prints or other drawings or tabulations of various kinds, and a draughting table with a glass top serves as an excellent means of accomplishing this result. The board should be built with an ordinary pine frame with a large plate glass set in the frame and arranged for illumination underneath. In order to diffuse the light a ground glass screen or a piece of oiled paper or tracing cloth should be placed under the glass. The lights should be strong enough to allow seeing through two thicknesses of ordinary blue print paper clearly and should be arranged to distribute the light as evenly as possible. For holding drawings on the board use a heavy paper mat fastened to the wooden frame. Cut a hole of the desired size, paste the drawing paper over same and then cut it off from the mat when finished."

Ill. No. 51.

Distribution Record System.

"In connection with the above plan, the following system of company records works out very nicely. Make to the same scale separate record maps of the distribution mains as follows: (1) A map showing streets only; (2) a skeleton map showing mains only; (3) a contour map showing elevations; (4) a map showing drips, etc. These maps can be placed over each other on the glass board above described in any desired combination and can also be blue printed in any desired combination."

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Handy Street Main Reference.

"A map of the street mains corrected weekly or monthly and placed under plate glass forming the top of the manager's desk and the application desk make a very handy reference. A prospective customer can be told at a glance whether he can get service."

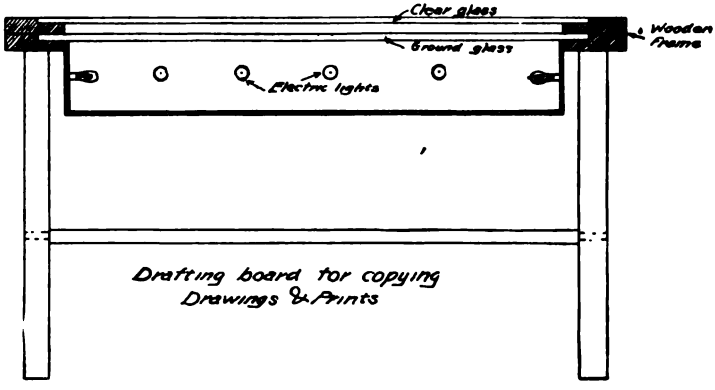
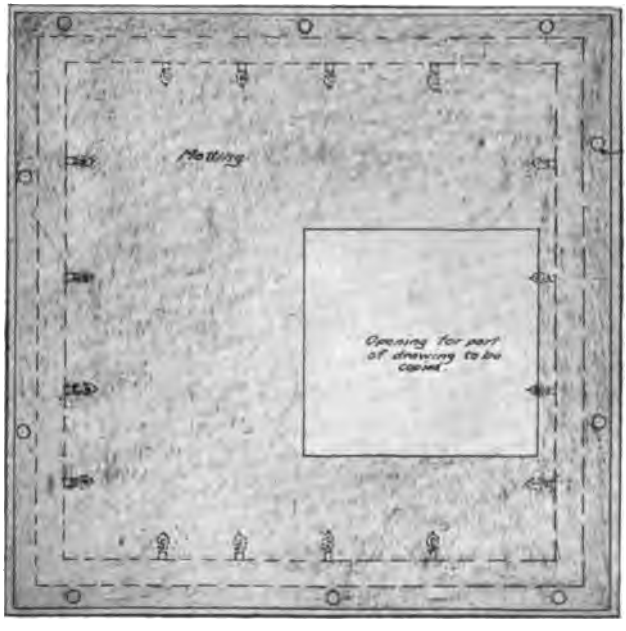


Fig. 1



Ill. No. 51.

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Orsat Apparatus for Accurate Analysis.

"The principal difficulty with the Orsat apparatus is to keep the solutions fresh and active as the solutions are still capable of considerable absorption after thev are too old to remove the last traces of CO and O. For this reason I suggest the use of two pipettes for each of those elements, one of which containing the older solution is first used to remove the bulk of the CO or O, and the other containing a fresh solution is used for removing the last traces of these gases. In this way the new solution remains in good condition much longer. For accurate work the sample of gas should be passed back into the caustic potash solution after passing through the other solutions."

— — —

Method of Increasing Capacity of Compressors.

"In our Pintsch plant at Denver we were unable to handle our load with the compressors installed. In order to get additional capacity we installed a Roots blower and later a small compressor worked at as high pressure as we could furnish and not stall the main compressor. This was found to be about 10 pounds per square inch and the capacity of the Pintsch compressor was increased about 66 per cent. When the Roots blower was belted to the main compressor in a mining plant, the steam consumption was increased only slightly to give a very material increase in capacity."

— — —

Meter for Pintsch Gas and High Pressure Distribution Systems.

"In many cases it is desirable to install a meter on moderately high pressures, as in natural gas, and recent high pressure distribution systems, and for that purpose an ordinary tin meter enclosed in a cast iron case is often very handy. The pressures inside and outside the case being equalized by a connection into the jacket and the meter, will then operate up to the usual differential pressures without trouble. The cast iron case should have a glass window in front of the meter dial and the readings should be corrected to correspond to the pressure carried."

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Method of Drying Coal or Coke.

"In many places where the coal is very wet at certain seasons, or where the coke is marketed immediately after quenching, it is desirable to dry them quickly and cheaply before using. For this purpose I suggest that hot flue gases from the bench stacks be pumped through the bunkers or bins. The temperature of the gases can be regulated by means of an air inlet on the suction side of the fan. In many cases this method will quickly remove snow and ice from the coal and improve carbonizing results materially and also prevent unnecessary damage to the retorts."

Method of Compensating for Insufficient Condensing and Scrubbing Capacity in Water Gas Plants.

"The use of a circular water spray around the inlet of the relief holder with the result of forcing the gas through a thin sheet or spray of water is of material assistance in removing the light tar vapors and in reducing the temperature of the gas. In the case of a relief holder where the gas is being constantly mixed and moved, the use of water on the relief holder cover is often of material assistance in cooling the gas."

Method of Using Cork in Purifying Material.

"Attention has been called to the desirability of cork as a diluent for purifying material on account of its light weight and of the fact that it does not grind up and become small when handled. For this reason we have used the same cork many times by merely floating it off from the iron when the material becomes inactive. We have found very little loss in the bulk of the cork after years of service, during which it has been floated off from the spent oxide and mixed with fresh oxide as many as twelve times. On this account the relatively high first cost of the cork has been more than compensated for by its long life."

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METHOD OF MEASURING THE RATE OF PROPAGATION OF FLAME.

"A simple method of measuring the rate of propagation of flame for different gases consists in metering the discharge through a calibrated orifice and increasing the flow until the flame leaves the edge of the orifice. A lava tip can be used or a plain orifice will serve the purpose.

CONTINUOUS CO_2 SAMPLING APPARATUS.

An apparatus for continuously withdrawing a small proportion of the flue gases from bench or boiler stacks, is shown in the attached sketch.

The closed tank B is placed in the open tank A. The sides of B extend below the bottom, forming an air chamber L. C is an angle valve with stem extended to work the disc at *c*. The flexible metallic hose *d* connects with a perforated pipe running through the stack. The tube *l* in connection with cock *x* permits of the air chamber L being filled or emptied as required. The pipe *n* prevents the air in L passing up into the tank B.

To operate the apparatus, fill both tanks with water, with the exception of a couple inches at the top of B, which must be filled with oil. Pump enough air into L to raise B several inches above the water level in tank A, and regulate the opening at *c* so that the tank fills in the given time.

It will be noted that as the air chamber L rises, the pressure due to the head of water gets less and the air expands, tending to increase the upward pressure on B, also as more of the tank rises out of the water, the total weight of B increases. These two forces oppose one another, and if the tank is properly proportioned, they will balance, thus causing a constant flow of water through *s* at any position of tank B.

The advantages claimed by makers of automatic CO_2 recorders is that the firemen can see at any time the results obtained. These conditions can be approximated with the above apparatus by taking frequent tests until the fireman is

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trained to his work. In actual practice it is found that the average fireman soon learns how to get results.

It is questionable if the average of a day's run taken from a recording apparatus is as accurate as that obtained from a sampling tank as above.

V. F. DEWEY,
Detroit City Gas Co.

Ill. No. 41.

SAMPLING TANK FOR GAS.

For photometric and calorimetric testing, it is often advantageous to get an average sample of gas passing through the main during a period of several hours or more. The ordinary method is to pass the gas into a sample holder, throttling the inlet to a point where the holder will fill in the given time. The effect of wire drawing the gas through the small inlet is found to be deleterious to the C. P., and also causes the holder to fill more or less rapidly as the specific gravity of the gas changes.

The sampling device shown in the attached sketch was designed to overcome these troubles.

B is a closed tank placed inside of the open tank A. C is an angle valve with a stem of such length that the disc seats at *c*. The holder is connected with the sampling line with metallic hose D. H is a flap valve of large area.

To operate, fill both tanks and turn gas on full, then adjust opening at *c* until the gas pressure forces the water from B to A at the rate required. The tank B will rise as it fills with gas, similar to an ordinary holder. Check valve H allows the tank to empty rapidly.

V. F. DEWEY,
Detroit City Gas Co.

Ill. No. 42.

CONSTANT WATER LEVEL FOR STATION METERS.

With stationary meters running at variable speeds, it is difficult to maintain a constant water level. The device shown in attached sketch owing to the small opening at C, does not allow

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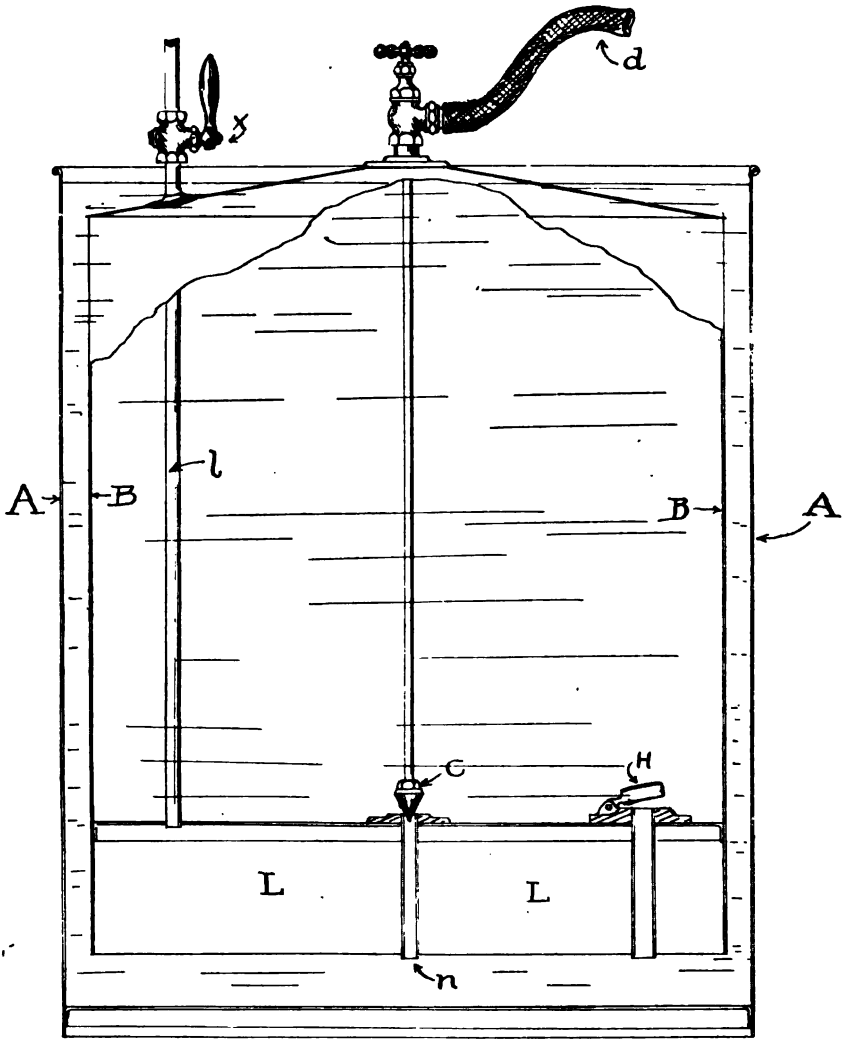

CONTINUOUS CO_2 SAMPLING APPARATUS.

Ill. No. 41.

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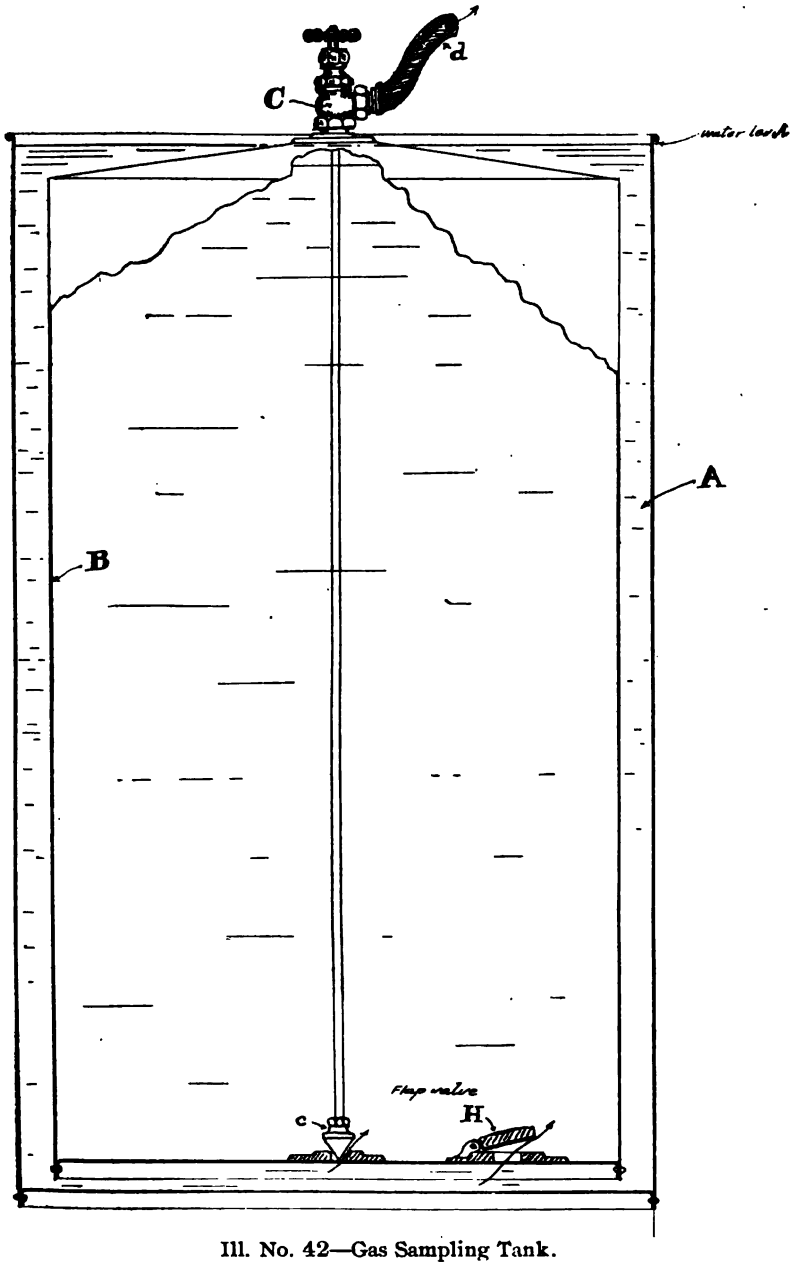

Ill. No. 42—Gas Sampling Tank.

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the meter to throw the water out at each oscillation in the drum, but is large enough to take care of any permanent change in the water level.

V. F. DEWEY,
Detroit City Gas Co.

Ill. No. 43.

CONTINUOUS RECORD OF DEPTH OF SEAL.

The attached sketch shows a method of recording the depth of seal on hydraulic main.

The end of pipe Y is placed flush with the bottom of the dip pipes, a small but continuous supply of gas is passed into the hydraulic through pipe X. The pressure on Y is equal to that on the dip pipes.

V. F. DEWEY,
Detroit City Gas Co.

Ill. No. 44.

OVERFLOW FOR HYDRAULIC MAIN.

The overflow shown in the attached sketch claims the following advantages:

1. The sides of the box B present a long edge for the water to pass over, thus permitting a large body of water to be pumped through the main without affecting the seal.

2. The overflow is open to atmospheric pressure, which makes the pressure on the retort entirely independent of the vacuum drawn by the exhauster (providing the changes of vacuum are not too sudden and the circulating water supplied the main is ample).

With above conditions the level of the water in the main will rise and fall proportional to the vacuum, but the pressure on the dip pipe will vary only with a change of the height of the overflow.

It is found to be perfectly safe in practice to carry a high vacuum on the main, which more thoroughly washes and cools the gas by passing it through a greater depth of water.

V. F. DEWEY,
Detroit City Gas Co.

Ill. No. 45.

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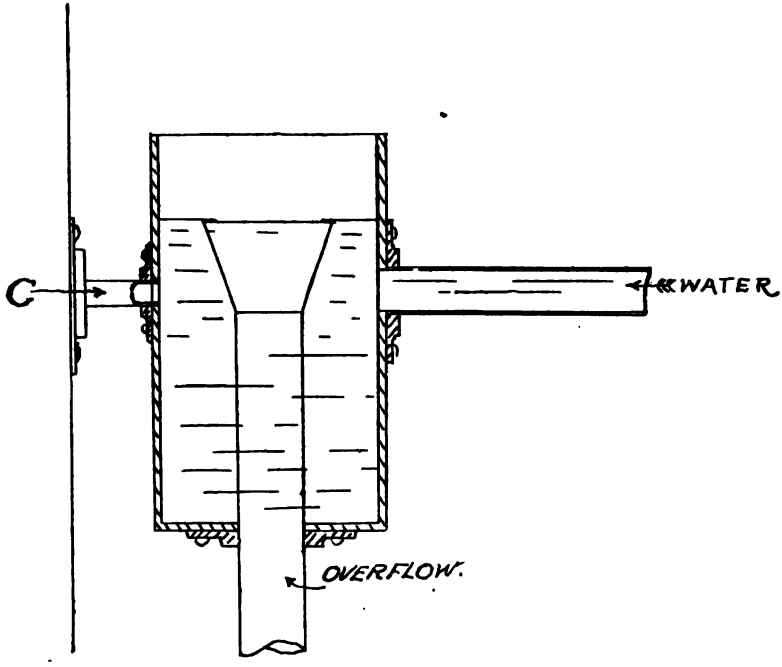

Ill. No. 43—Station Meter Overflow.

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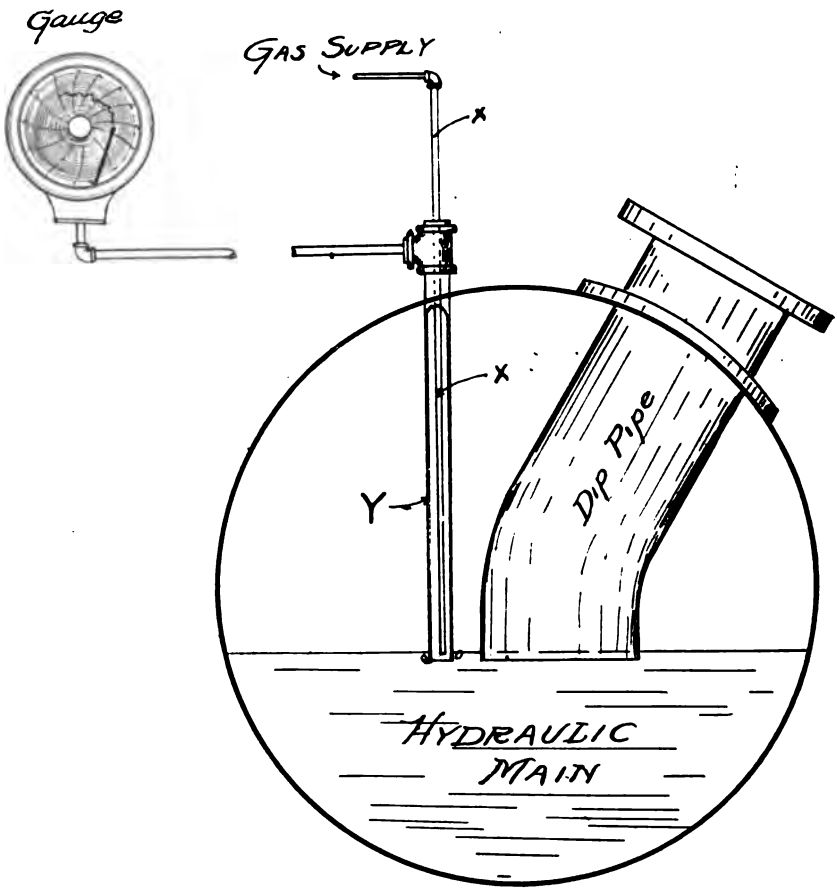

Ill. No. 44—Record of Depth of Seal on Hydraulic Main.

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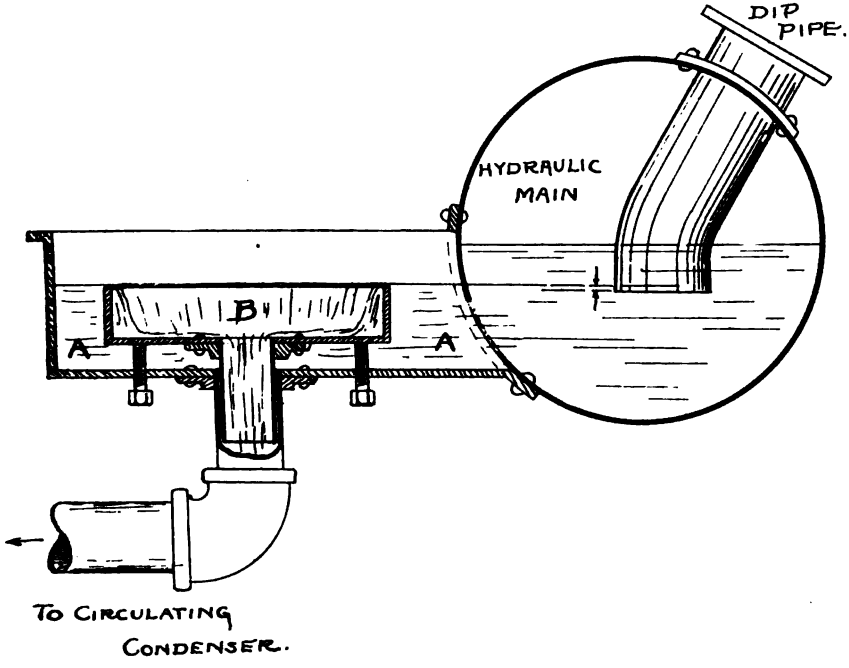

Ill. No. 45—Overflow for Hydraulic Main.

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Method of Cleaning House Piping.

This method consists in using compressed air for cleaning house services. The air (or gas) is compressed into a main storage tank to about 200 pounds pressure, and delivered from this tank to a wagon tank carrying about 140 pounds pressure. From the wagon tank the air is drawn into small tanks, such as are used for air brakes on street cars.

By means of this plan two men with a wagon will average 15 to 16 cleans per day, against 9 or 10 with the old hand pump.

Garnet W. McKee,
Detroit City Gas Co.

Ill. No. 46.

Total Sulphur in Oxide.

Where a frequent determination of total sulphur in oxide is made, the following method will be found equally accurate and more rapid than the ordinary extraction, or slow oxidation method.

A bomb similar to the accompanying cut is needed, may be easily made, and should be of brass.

A is bored out of 1 inch brass and threaded for the lock nut C, which draws B down on the gasket D, making the bomb gas tight. This gasket, D, may be of any suitable sulphur free material.

The post extends through the shaft B and must be insulated at F. G is a second post, screwed into B.

H is an ordinary 64 gauge iron wire, which serves to complete the circuit, when three or four dry batteries in series are attached by contact on E and any point on A.

To make a determination, place in the bomb about 10 grams of sodium peroxide; add ¾ gram of an oxidizing mixture composed of 11 parts boric acid, 4 parts potassium chlorate and 1 part magnesium oxide, ½ gram of the dried and pulverized oxide, and ¼ gram of naphthalene or ½ gram of pulverized coal whose sulphur content is known. Mix thoroughly. Close bomb and explode charge by closing the circuit as before stated, taking the precaution, however, to immerse the bomb

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Ill. No. 46—Compressed Air Method of Cleaning House Piping.

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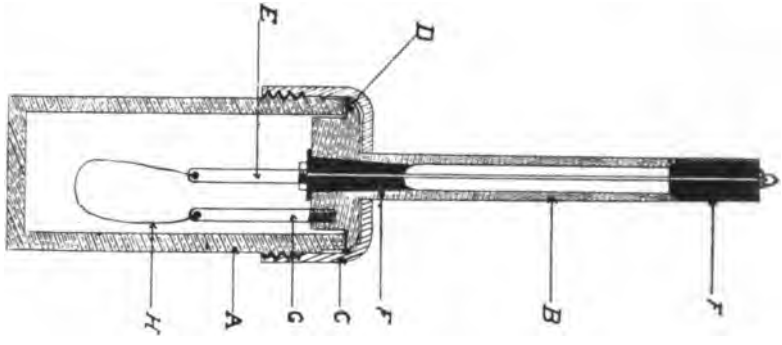
in about a quart of water, otherwise the bomb is liable to fuse from the heat generated by the rapid combustion. After cooling, open bomb, dissolve out charge with hot water and precipitate the sulphur by the usual method.

The total time required for operation up to the point of precipitation with barium chloride is not more than ten minutes.

With proper modification, this method is applicable for the estimation of total sulphur in any combustible substance.

R. M. REDDING, Chemist,
Laboratory N. O. Gas Light Co.



DEVICE TO MAINTAIN CONSTANT OPERATION OF AMMONIA SCRUBBER PUMP.

Lever of throttle valve marked A is attached to float in overflow pit by means of cable, which passes over pulleys B-B. Counter weight C is attached to end of cable.

Liquor flowing into overflow pit is pumped into primary scrubber. As level of liquor changes in pit the float acts on lever of throttle valve, causing same to open or close, thus maintaining a constant working of pump.

H. E. MANN,
Cleveland Gas Light & Coke Co.

Ill. No. 39.

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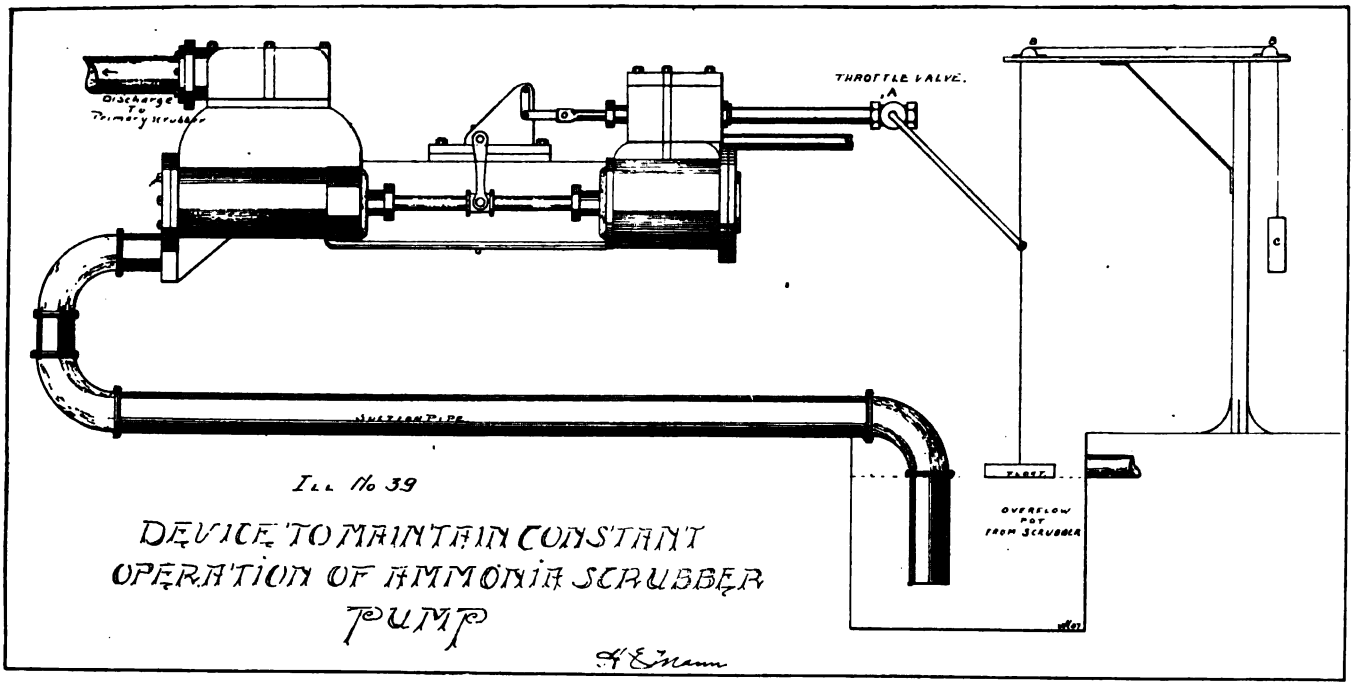

Ill No 39

DEVICE TO MAINTAIN CONSTANT OPERATION OF AMMONIA SCRUBBER PUMP

H. E. Irwin

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THE PRESIDENT: Gentlemen, you have heard the report of Mr. Bump for the Wrinkle Department.

A MEMBER: Mr. President, I move that we accept the report which Mr. Bump has submitted, that we extend him the thanks of the Institute for his work, and that he be continued as Editor for next year.

Motion seconded.

THE PRESIDENT: The motion is that the Institute extend its thanks to Mr. Bump for the work which he has done in collecting wrinkles, and that he be continued as Editor of the Wrinkle Department. All in favor say "Aye." Contrary minds, "No." It is carried.

The next business is the report of the Committee on Methods of Taking Candle-Power of Gas, Mr. W. H. Gartley, Chairman.

Mr. Gartley, how long will it take to read your paper? I ask that question because we can interrupt the discussion, but I would not like to interrupt the reading of the paper. Perhaps it would be better to summarize the paper.

MR. GARTLEY: Mr. President and Gentlemen: This report occupies a good many pages in the book which has been printed, and those of you who have read it, and those of you who will read it, will see that the committee has not attempted to lay down any hard and fast rules as to the method of taking candle-power of gas. That was a condition which it would be hardly fair for the Institute to impose upon us, and the committee did not think that it was called upon to attempt it. The report is intended to cover most of the features, or intended to cover step by step how a proper photometric test should be made. It is shown what kind of a room the photometer bar should be installed in, and what is generally requisite for the installation of a photometer. While the report does not recommend the adoption of any one standard, it has presented the facts regarding the well known lamps and others in such a way as to assist in making a wise selection.

The question of a standard is a very important one. The report does not offer very much encouragement to those men

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who believe that the proper way to make an accurate determination of candle-power of gas is by one or a pair, or half a dozen pair of any standard candles. They have endeavored to point out, however, that the candle itself is an unreliable standard. The question at this day is becoming more and more acute. Gas companies are being called upon to deliver a certain number of candles, a fixed candle-power, and they are, in a great many instances, subject to penalties if they do not do it. We hope that the report of the committee will assist the inspectors of municipalities and state commissions to get a proper installation of the proper instruments and proper detail of apparatus, and then to take the readings in a proper way.

The Illuminating Engineering Society has taken the initiative in endeavoring to fix upon a value for the unit of light. That is something which every one, as it seems to me, needs. It is nearly time that we should agree. The International Photometerical Committee which met this year in Zurich has done some work along that line, and has arrived at some conclusions. The intention is that the Institute and associations that are interested in the subject of municipal lighting shall appoint representatives to a committee who will consider the whole subject of getting up or adopting a definite unit of illuminating value. I want to read a portion of the report which refers to that. That portion will be found on page 478. (See report under the head of "The Unit" down to Appendix A.)

Now I want to say that it is not proposed that the gas companies will take a low voltage electric light and use that as a standard for gas at all. Of course, there is a difference between the two. Such a course would only give confusing results, because, while the gas flame would be influenced to a marked degree by changeable atmospheric condition, the electric lamp would be unaffected. It is intended that the flame standard against which the gas is to be compared will be given a value by taking it to a laboratory in which it may be compared against a standard electric glow lamp, the flame standard being burned in a normal atmosphere or in an atmosphere of known water vapor and carbonic acid content from which its

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value in a normal atmosphere might be calculated. The electric glow lamp having had its value fixed in multiples of the unit of light, by comparison with the standard lamps in possession of the Bureau of Standards at Washington, and your flame standard lamp having been given a certified value in terms of the unit, you have a standard against which to compare your gas that will be influenced by changes in atmospheric conditions almost exactly to the same degree as the gas flame.

I want to say that the committee is under a great many obligations to the Bureau of Standards at Washington. Dr. Hyde was in our laboratory at Philadelphia and conducted a series of experiments regarding the pentane lamp which showed the effect of these atmospheric conditions on the pentane lamp. The experiments conducted there were such that they led us to carry on some more extended experiments with better equipment which he suggested to us, and the results are found in this report.

I do not think it is necessary to take the time further.

REPORT OF COMMITTEE ON METHODS OF TAKING CANDLE POWER OF GAS.

Room.

Your Committee on Methods of Taking Candle Power of Gas recommend that, for continuous and accurate testing and for convenience in operation, the photometer room in which the 60 inch bar photometer is installed should not be less than 14 feet 9 inches long when gas from one supply is to be measured. Where gas from more than one supply is to be measured, a separate meter for each supply should be provided. (See photometer meters, page 465, paragraph 6.) For each additional meter set upon the extended photometer table, add 1 foot 6 inches to the length of the photometer room.

The width of the photometer room should be not less than 8 feet 6 inches.

The height of the photometer room should be not less than 12 feet. These dimensions as to length and width are the

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least that will permit of convenience in movement about the photometer, the table of which is to be 8 feet 9 inches long and 2 feet 6 inches wide, when a single meter is used. The minimum height of 12 feet is given from considerations of ventilation.

VENTILATION.

If any wall of the photometer room is formed by a wall of the building in contact with the outside air, that wall should be jacketed with non-conducting material to make it readily maintain the same temperature as those sides communicating with the interior of the building. No room having walls of considerable difference of temperature can be free from drafts.

The photometer room is in best condition when built in the middle of a room that is warmed and well ventilated, and not used for any purpose tending to vitiation of its atmosphere. In this case, the photometer room may receive for its proper ventilation a supply, in cold weather, of pure, warm air from the outer room, while its sides are exposed to a uniform temperature on the outside and to a uniform temperature on the inside; and in warmer seasons it is protected from the direct rays of the sun.

While the air in the photometer room is best supplied from the outside room, the flues discharging the vitiated air from it may open into the outside room again if the height of this room is not less than ten feet above the ceiling of the photometer room. In this case, the openings in the ceiling of the photometer room should extend the full length of the photometer table and should be light tight.

If the height of the outside room is less than this limit, the ventilation of the photometer room should be carried on by means of light tight ventilators controlled by a damper. In this case the openings in the ceiling of the photometer room should discharge into a box, to which these ventilators are connected, and the ventilators should be carried through the roof of the outer room.

The air may be admitted to the photometer room through suitable openings in the outer side of the walls or partitions, thence downward with a sufficient offset to exclude light, and

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then into the room through registers set in the baseboard. These openings should extend around the entire room. The total area of the register openings, for a room of the minimum size given herein, should not be less than ten square feet, made up of twenty-four registers, 6 inches by 10 inches, or their equivalent.

For the purpose of light and ventilation when gas pipes are to be disconnected, and for cleaning, two or more light tight shutters, opening into the outside room, should be provided.

Such a room will permit of the continued presence of two persons, a 5 foot per hour gas flame and the flame of the pentane lamp, and yet maintain a low degree of vitiation, without drafts. (See Appendix A—part 2.)

Vitiation Effects.

The charts of Appendix A show the relative effects of vitiation on approximately 22 candle power mixed coal and water gas, and on some of the standards of light that are now in use.

The percentage of loss in candle power of the gas flame being less than that of any of the standards shown, we can safely assume that any vitiation of the atmosphere beyond the normal will cause the candle power of the gas flame to show higher than it would if measured under normal conditions. This, of course, presupposes that the formulæ corrections for humidity and carbonic acid content as supplied to the flame standards have not been used. These charts are also interesting as showing that the divergencies between the gas flame and the candles are greater than between the gas flame and the pentane lamp or the Elliott lamp.

The photometer room, therefore, should be supplied with an abundant quantity of air, uniform in purity and in temperature, from the outside room, the temperature of which may be kept uniform either by the indirect or the hot air system of heating. If the location is such that there is no one present at night, a gas stove or electric heater could well be employed to maintain the temperature at the desired degree during off hours.

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Humidity Effects.

In those climates in which the heat of the summer is accompanied by high humidity, there is introduced a problem which is difficult to solve. A very disturbing factor in correct candle power determinations is the change in the quantity of water vapor present in the air. While in the winter the humidity will be below normal at the temperature of the photometer room, it can be brought up to normal; but in the summer, the problem is to reduce the humidity. The introduction of methods of cooling the air during the summer months, by which the humidity may be controlled, appears to be essential for correct work.

Formulæ for correcting the candle power of the pentane and Hefner lamps for variations in the humidity and carbonic acid content of the atmosphere supporting combustion of their fuels have been deduced empirically by Mr. Paterson of the British National Physical Laboratory and Dr. Liebenthal of the Reichsanstalt. In these cases, however, great care has been observed to keep the fuel of these lamps exactly constant in composition.

We could not expect to apply any formulæ for these atmospheric constituents to a flame of varying composition such as changeable gases requiring different quantities of air. Consequently, when we compare a gas flame against another flame standard, we must either have normal atmospheric conditions in the room or we must know that these atmospheric conditions influence the flames of the standard and the gas exactly alike. To compare a gas flame against an electric lamp normal atmospheric conditions are imperative, otherwise an error of as much as 10 per cent. may be introduced generally against the gas flame.

The photometer room and laboratory of the Bureau of Standards at Washington is equipped with cool brine coils, over which the air to the photometer room is passed, thus reducing the quantity of water vapor.

The range of absolute error which is attributable to this humidity cause alone is set forth in Mr. J. B. Klumpp's Notes in the Report of the Research Committee of The American Gas Light Association in 1905, in which the pentane lamp value is shown to be subject to a total variation of as much as 25 per cent. between the extreme ranges of humidity in Philadelphia in a year.

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Temperature Control.

The temperature control of the photometer room is a matter of prime importance. Not only must the pipes conducting the gas to the photometer room be protected from chilling below the minimum temperature of the gas in the mains, but fluctuations in the temperature of the photometer room during the times when the readings are not being taken constitute a cause that leads to frequent inaccurate determinations.

Gases depend for their illuminating quality more or less on the condensible vapor. When a gas passes through a pipe the sides of the pipe become coated with a condensate from the gas that will, if the temperature and the gas do not change, remain in equilibrium with the vapors in the gas. In other words, there will be no interaction between this condensate and the vapors in the gas. If the temperature of the condensate changes even slightly, it will no longer be in equilibrium with the vapors in the gas; and there will be an absorption of the vapors of the gas if the pipe gets colder, or there will be a yielding up of the vapors to the gas if the pipe gets warmer, resulting in a temporary decrease or increase in the candle power.

What is true of the pipe is particularly true of the photometer meter. The meter water is also influenced through the fact that the solubility of benzene vapors in water is affected by temperature. Like ammonia, so with benzene vapors; cold water will absorb more of them than hot water will. It is for these reasons that a sudden increase in the temperature of the photometer room will give temporarily a higher reading of a gas flame.

In Appendix B is given the result of the experiments to show the influence on the candle power of passing gas through meters in which the temperature has been changed.

An even temperature of 75° F. in the photometer room throughout the year is desirable.

Construction.

The photometer room may be constructed of metal, such as corrugated or stamped iron, or of wood, or of brick, or tile.

The photometer room shown in plate 1 of Appendix A is shown as made of sheet iron.

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Photometer.

The Committee recommends the use of the 60 inch bar of the improved Letheby type, and does so without prejudice to the 80 inch or 100 inch bars. After diligent inquiry among the gas companies, it is believed to be their tendency to equip themselves with 60 inch bars, and they seem to have been governed by the consideration that more 60 inch bars of modern design are being used than any other.

Of ninety-eight sets of questions sent out to the larger gas companies, seventy-three companies replied; of these sixty-two companies use bar photometers. They have in use 83 bar photometers, of which 37 are 60 inch, 29 are 100 inch, and 4 are 80 inch bars.

The advantages of the 60 inch bar are:

First. That being shorter, it requires less space.

Second. That the two light sources usually compared in plain gas photometry are at such relative distances from the disc as to give it the best theoretical illumination for easily comparing the star or other figure on the disc.

Assuming as normal for America a 10 candle power standard and a 20 candle power gas, the disc box at correct setting will, on a 60 inch bar, be about 2.07 feet from the 10 candle light; and, on a 100 inch bar it will be 3.45 feet from the 10 candle light. The setting being correct, the illumination on both sides of the disc will be equal.

The human eye has objects best illuminated to suit its vision, that is for sensitive discernment of differences in appearance, when that illumination is from 2 to 3 foot candles.

Computing, therefore, from the above figures, we find that for the 60 inch bar the disc has an illumination of $\frac{10}{(2.07)^2} = 2.34$ foot candles; and that for the 100 inch bar the illumination is deficient, being only one-third this, or $\frac{10}{(3.45)^2} = .84$ foot candles. The 100 inch bar with a 10 candle power standard is well adapted for the determination of incandescent mantle lights where the range is from 60 to 100 candles.

The objection may be urged against any form of straight

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bar photometer, such as the Letheby, that while the standard lamp used had had its value assigned when it was at one distance from the disc, yet in the operation of taking varying candle powers the standard lamp is used at varying distances from the disc, and the nearer the lamp is to the disc the greater is the light area of its flame at the disc. In some cases, such as the Edgerton Standard, this has been met by an accurate determination of the effective centre of the Edgerton standard flame, which was then placed in the position of the standard light source.

The effective centre of the circular flame of the pentane lamp is at a point forward of the geometric centre, a distance equal to one-third the radius of the flame; so that if the lamp is set up with its effective centre 30 inches distant from the centre of the bar, the effect of varying the distance of the disc from the pentane lamp will be neutralized and accuracy maintained.

The art of photometry of gas flames has been much advanced by the work of the Gas Referees in London and their associates. These gentlemen, acting as arbitrators between the gas companies and the municipal authorities for many years, have brought to bear on most of the questions that have presented themselves—and it would seem that almost every possible question had presented itself—a high degree of technical knowledge and practical experience. Their decisions and the results of their investigations are entitled to the highest respect, and the investigator who differs with their findings should realize that such responsibility must not be assumed lightly. One of the limitations of the work of the London Gas Referees must be kept in mind—they deal with London gas as burnt in the City of London. The methods and apparatus used by them may not be practicable for gases of wide range in candle power.

The Gas Referees of London and their associates made a thorough study of the advantages and peculiarities of different types of photometers prior to the adoption of the new table photometer in 1898. This photometer is a modified form of the Foucault, and is similar in principle to that used in Paris. The objection just cited is here met by fixing the positions

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of both standard and test light, and also of the disc, or "photoped" as it is called. The ten candle pentane lamp was placed 1000 mm., and the London Argand Burner 1265 mm., respectively, distant from and on the same side of the photoped. All other distances of importance were similarly fixed with exactness, so that it would be possible to turn out a series of uniform instruments. The adjustment of equality of the disc's illumination was gained through varying the rate of flow of the gas, and this equality is judged from the rear of the photoped by transmitted light.

Such a method was not flexible, however, as it would not easily permit the testing of gases varying widely in candle power, nor the use at the same distance of both Argand and flat flame burners. We find, however, that in the 1907 Notifications, the Referees have returned to the principle of moveable parts; but in this case it is the test flame which is made to move and not the disc. We are not able to persuade ourselves that this is the best method of meeting all the difficulties.

It seems to the Committee that, as one requisite of accurate photometry is that both flames shall be as quiet as possible, it is a wide departure from this accepted stand to oscillate the test flame to and fro during a determination of the gas burning through it.

It was desired that actual tests should be conducted to find whether the Table Photometer in operation had advantages over the type which the Committee recommends. For this purpose one was imported from London. It was set up in a room 27 feet 9 inches by 18 feet 6 inches and 16 feet high, containing a 60 inch bar photometer and a 125 cubic foot gas holder. In this way it was possible to furnish the identical gas to each photometer, and to maintain all temperature and atmospheric conditions equal.

The photometrists, after considerable practice to enable them to do consistent work on the Table Photometer, report that while its design is to give greater convenience to the opertor and permit him to remain seated during a test, they are not able to make a setting with as great readiness nor within as narrow limits as with the other photometer. As a consequence

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there is a wide disagreement of the readings by the same individual, although the average by the two methods is not far from agreement. More practice may bring greater skill, but at present they do not see any refinement in observation by comparison of the two fields on the photoped. Apart from this criticism, the Table Photometer is the logical development toward the elimination of several disturbing factors, such as "personal equation" and varying distance of standard from disc.

Two other points should be mentioned while speaking of the possibility of adoption of such a Table Photometer in American practice. It would not be feasible to place more meters upon such a table for the purpose of testing different gases on a Works photometer, because the space on the table near the observer is already filled. Secondly, it would be advocating the abandonment entirely of the present photometric equipment in this country, for we are unable to learn of the use of such Table Photometers here.

The Committee is of the opinion that while advocating the continued use of the bar photometer, yet every means contributing to its greater accuracy should be encouraged. To this end we recommend the "substitution" method in testing gas.

It is known that in most cases if two lamps A and B prove equal when A is at the left of the bar and B is at the right, yet they may differ slightly when B is at the left and A is at the right. This may be due to personal equation, to air drafts, to unequal reflecting surfaces, or other contributing causes. If, however, A is known to have a standard value, and the desire is to test the candle power of the gas against A's units, then substitute A in the place that will be used by the gas and evaluate B in A's terms in the position which it (B) will continue to occupy. All that is now desired of B is that it shall continue constant, yielding always the value given it by A's units. A is then taken away and the gas is swung into the position which A occupied. It is here subject to exactly the same environment that A had, and, through comparisons with B, obtains its candle power in terms of A.

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Furthermore, A, being the standard of reference, is used least and will be preserved longer.

The installation of photometric apparatus necessary for the exact, or approximately exact, valuation of a gas flame requires a stable equipment. Attention must be given to many details of the care of the gas in its approach to the room and in its treatment in the room. We call attention to the grave sources of error capable of the widest ranges of injustice that are introduced when these details are not observed. The determination of the candle power on portable photometers must be accepted with the greatest caution. Of this class of photometers it must be said that accuracy is often sacrificed to convenience of handling. The usual sources of error in a portable photometer are as follows:

First. The photometer is closed in and thus supplied with vitiated air; also under this condition such air as the flames get is supplied through small crevices and accompanied by drafts.

Second. The body of the photometer is not rigid, and the movement backward and forward of the disc box causes vibration of the flame.

Third. The disc box is set so near the bed of the table that the dust gathering upon the table may easily become appreciably a reflecting surface.

Fourth. Many of these portable photometers are without a governor or without a device for measuring pressure.

Fifth. It is a common practice to use rubber tubing in connection with them, such tubing having the property of absorbing benzene vapors and reducing the candle power.

Sixth. A photometer equipment comprises a proper preparation of room as to ventilation and temperature, careful guarding of the gas against chilling, and other precautions against error that will not be found if the photometer is set up anywhere and everywhere.

Piping.

The temperature of the gas in the pipe conveying the sample from the main to the photometer should not be allowed to fall below the minimum temperature in the main. The service

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pipe should be taken from a point not above the middle of the main, and where it is carried under a water tight pavement should have only a slight drip back to the main. It is better to drip the piping toward the cellar, thereby securing more cover to the service pipe than to the main. In the cellar of the building, it should be protected carefully against chilling. The pipe should run as direct as possible to the photometer and should be covered with non-conducting covering.

Several companies have adopted the use of cooling coils on Works photometer, through which the gas passes before entering the photometer meter, thus securing at all times of the year the candle power of the gas at a constant temperature. By observations with the hygrometer (as devised by Bond and Tutwiler, of the Philadelphia Gas Works), at the Testing Station, the temperature to which the gas has fallen before reaching the testing station photometer may be determined, and the fall in candle power, due thereto, may thus be anticipated at the Works.

The use of pure or vulcanized rubber hose for conducting gas to a photometer is condemned as decreasing the candle power of the gas.

Governor.

In order to secure exact measurements on the photometer meter, the gas in the inside of the meter drum should be under uniform pressure. For this purpose a governor should be placed on the inlet to the photometer meter. The Committee recommends the use of a dry governor, which, while somewhat less delicate than a wet governor, avoids the two objections to a wet governor: namely, first, the more attention that it requires and the introduction of fresh water from time to time which must be saturated before a correct reading is to be made; second, the wet governor acts as an averaging tank and will not show as rapidly as the dry governor changes in the candle power.

A dry governor, smaller in size and capable of delicate adjustment, should be placed on the outlet of the photometer meter to still further reduce the pressure supplied to the burner, and to obviate small fluctuations caused by the dipping of the meter partitions into the water.

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Forty-two companies report using dry and eighteen, wet governors; those using governors at inlet only, those at outlet only, and those at both inlet and outlet are about equal in numbers.

Meter.

The Committee recommends the adoption of the 1-12 cu. ft. per revolution wet photometer meter, unencumbered by a superimposed clock. The rate of flow of the gas should be determined by a detached watch or clock. With a 1-12 cu. ft. per revolution meter, the gas is being burnt at the rate of five cubic feet per hour when the meter makes one revolution per minute. The observer can watch the meter dial with his eye and snap the watch at the completion of a revolution of the meter hand. He then reads from his watch the number of seconds required for a revolution.

The candle power computer is based on the use of the 1-12 cu. ft. per revolution meter.

The speed of the drum throughout a revolution should be as nearly as possible exactly uniform. Should the movement of the meter hand appear erratic, a leak should be suspected, and a test made to ascertain if this is true. It may be occasioned either by friction of the circumference of the drum or by its shaft, due either to a deposit of sediment below the drum or to dryness of the stuffing box. Either cause will produce an erratic motion and be accompanied by fluctuations of the water in the gauge glass.

Clear water should be used in the meter, and it is at the correct height when the bottom of the meniscus is at the height of the pointer on the glass. The drum should revolve freely with a 1-10th inch pressure.

The meter should not be connected rigidly with wrought iron pipe at the inlet and outlet, as such connections render the leveling screws inoperative without straining the meter. Lead connections are preferred. It is best to set the meter and level it first and then bend the connections into place.

When gas from more than one supply is to be measured in sequence on the photometer, a separate meter should be provided for each kind of gas, in order to secure, in the shortest

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interval of time, accurate determinations. For instance, if a higher candle power water gas is passed through a meter which has previously been measuring coal gas, a considerable time must elapse before the water in the meter gets in equilibrium with the vapors in the higher candle power gas. Until this is accomplished, the reading will be too low.

In a Works manufacturing a mixed gas, in which the candle powers of the coal gas, the water gas, the mixed gas at inlet and the gas from the street governor outlet are to be measured, four separate meters are recommended.

The photometer equipment should include a 1-12 cubic foot glass bottle, such as are supplied by photometer makers. Its capacity should be derived from a cubic foot bottle certified by the Bureau of Standards at Washington.

A duplicate meter, proven correct by a cubic foot bottle, should be always on hand for releasing the meter in use to be tested when any cause for suspecting its accuracy arises.

Five companies replied that they did not correct the volume of gas burned to 60° temperature, and four make no corrections for barometric pressure.

Forty-two companies use 1-12 cu. ft. meters, sixteen use 1-10 cu. ft. meters, others use both.

Stop Watch or Clock.

Stop watches are generally unsatisfactory because of readiness to get out of order. A good stop watch in individual cases is reliable, but for frequent work it is expensive to keep in repair. A watch that would lose five minutes a day at a uniform rate would introduce an error of less than a third of 1 per cent. An electrically controlled clock of substantial workmanship, placed in a safe position and operated by three keys, for the purpose of starting, stopping and setting back the hand, is on the market and forms a reliable instrument.

The Swing Bracket.

The burner should be carried on a swing bracket supplied with a plumb bob for placing the flame at the proper distance from the centre of the bar. A swing bracket will permit of the

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placing of the pentane lamp by the substitution method. For exact alignment of the flame, two plumb bobs should be used, one on each side of the flame at right angles to the direction of the bar and each 30 inches from its centre. The flame is adjusted in final position by sighting across these lines.

Disc Box.

The disc box containing the disc is referred to by many writers as the "photometer." Stine says: "The act of measurement involved in photometry is confined to observations of the illumination of the lights compared upon some form of screen; and taking this as a basis, the photometer is the screen and its accessories."

The Committee recommends the Leeson Contrast Disc as being the simplest disc to reproduce, keep clean, read without fatigue to the eye, and not wanting in accuracy. In gas photometry the slight irregularities of the meter, the possibility of slight drafts, the dancing of the gas flame itself, makes the use of the Lummer Brodhun Disc fatiguing to the eye. Tests made by two set of observers on the same gas, reading against an electric standard—one set using the Leeson disc, and the other the Lummer Brodhun contrast disc—proved that under skilled observers they were equally accurate.

The human eye fatigues perceptibly with a Leeson contrast disc after eight hours of work, and much more quickly when reading with the telescopic disc.

Twelve companies report the use of the Bunsen or grease spot.

Twenty-four companies use the Leeson contrast disc.

Twenty-four companies use the disappearing star.

Eight companies use the Lummer Brodhun, of which seven are disappearing and one contrast.

Burner.

The kind of test burner that should be used has been the subject of much controversy. It is frequently specified with the candle power of the gas to be produced.

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The London Gas Act of 1905 contains the following clause:

> "CLAUSE 3. The Gas Referees shall from time to time prescribe the burner for testing the illuminating power of the gas supplied by the company and the chimney (if any) to be used with such burner. The burner so prescribed shall be of such pattern (not being an incandescent or similar burner) as shall be practical for use by the consumer; and the burner and chimney (if any) shall be the most suitable for obtaining, and in making the test shall be so used as to obtain from the gas when consumed at the rate of five cubic feet an hour, the greatest amount of light."

The English view is thus summarized editorially in the *London Journal of Gas Lighting* for July 14th, 1903: "The fundamental law of gas testing for illuminating power is that this shall be done with the burner best suited for the purpose, used in the most favorable way for the gas, provided only that the burner itself shall be one which consumers can use if they please. Except to the wilfully blind, there cannot be the smallest mistake as to the intent of this enactment, which has been justly styled 'the charter' of the illuminating gas industry."

The Gas Act referred to above embodies the conclusion arrived at after a thorough discussion of the subject by the London County Council (representing the municipality), and the gas companies. It will be impossible here to even outline the arguments presented on both sides; but the question seems to have been settled for the future by the adoption of the Metropolitan No. 2 Argand Burner, one of which is here on exhibition.

It consists of a carefully made Argand burner, fitted below with an air shutter by which the supply of air to the interior of the flame may be regulated. The burner as constructed makes a marked gain in efficiency over the Sugg D burner for gases of low quality.

The Committee calls special attention to that clause of the London Gas Act of 1905, describing the kind of burner that should be used in testing the candle power of gas, as cited

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above; and you are asked to note that this is an Act of Legislation and not alone the views of the gas companies, and that on this subject the municipal officials and the gas companies are in accord.

ON THE VARIOUS WORKING STANDARDS IN PRESENT USE:

In the reports received from the various gas companies of America, we find the following working standards to be in use:

A. British Candles—of several importations. Used by 31 of the 40 municipal and state inspectors and by 41 gas companies.
B. Edgerton Standards. Used by 18 gas companies; no municipal or state inspectors.
C. Hefner Lamps. Used by 1 municipal inspector and 5 gas companies.
D. Electric Incandescent Lamps. Used by 2 municipal inspectors; no gas companies.
E. Elliott Lamps. Used by 11 gas companies.
F. Pentane Lamps. Used by 31 gas companies and 3 municipal inspectors.
G. Jet Photometers, variously manipulated. Used by 28 gas companies, 20 of which also use bar photometers.

We should note that each of these standards is the product of incandescent carbon, and that their variety occurs through the effect of the media in which incandescence is produced.

The electric lamp produces incandescence of fixed carbon particles in a vacuum by direct molecular agitation by an electric current. It is not, therefore, affected by variations in the surrounding air, and is not to be recommended for photometry of gas flames.

In all the others, the carbon particles are dissociated in a free stream and are rendered incandescent by the direct application of heat through a combustion of gases whose oxygen supply is the surrounding air. Their flames are either a single jet or a series of jets arranged in flat or circular form. These flames are either freely open, partly directed, or wholly enclosed and directed by a chimney.

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The attempt to preserve their luminosity constant is made in either of two ways: first, by a uniform consumption of fuel; second, by the maintenance of a constant flame height. But so long as the flame and its temperature is dependent upon a surrounding air of varying quality, the luminosity of the free carbon particles will also vary, for this luminosity varies as the fifth power of the absolute flame temperature.

From this and the fact that humidity in the air exerts the greatest effect upon flame luminosity, it is clear that the real cause of variation in the several standards is the change in flame temperature. This knowledge should aid us in the selection of a standard; for we should choose that one which, while otherwise constant and reproducible, comes nearest to being affected by atmospheric changes exactly as our test flame is affected. In other words, we should expect it to be a flame of similar dimension, temperature and air consumption to our test flame. These conditions in the list of standards given are nearest met by the 10 candle pentane lamp, as is shown in the vitiation tests already referred to.

It may be well here to define the ideal working standard for gas photometry, as conceived by the Committee:

First. The lamp should be readily portable, of simple construction and unvarying dimensions.

Second. It should have an independent fuel, reasonable in price and readily procurable, which should be of definite chemical composition, with a fixed boiling point.

Third. The flames should be of the same order of luminosity as the test flames, of a similar color, fed without a wick, at a constant pressure, through a constant opening. No chimney should surround it.

Fourth. The lamp should be burned in a quiet room of uniform temperature and be supplied with pure air of the same temperature. After reaching thermal equilibrium, its flame height should be set and all the conditions named above having been complied with, the flame height and flame value will remain unchanged for that particular atmospheric condition.

Fifth. The flame of the standard lamp should be influenced in percentage of its normal value by atmospheric changes in

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exactly the same degree as those changes influence the value of the gas flame to be measured.

A Brief Description Follows of the Several Working Standards Mentioned.

Of the 41 gas companies using candles, 24 state that they are satisfied and 16 that they are not.

(A) A history and discussion of the standard candles is presented in Appendix D.

It presents the indictment against the practicability of use of the English Standard Candle as a standard of light:

First. Because it will not always burn within the prescribed limits of time. In warmer climates, it frequently burns outside of the prescribed limits more than 50 per cent of the time. In many of the cities of this country below the 42° parallel of latitude, it is necessary to keep the candles on ice or in ice boxes. The rejection of photometrical observations because of candles burning outside of the prescribed limits makes an almost prohibitive bar to systematic work.

Second. When burning within the prescribed limits it yields a light of varying intensity, due not only to the apparent failure to make candles conform precisely to the specifications, but to the fact that even if the specifications were exactly fulfilled in several candles, their light would not be uniform; and furthermore, to the effect of atmospheric conditions upon that light.

Any attempt to exactly measure these influences, such as humidity, would of course be greatly complicated by the knowledge that the candle, in the composition of its fuel, the wick and its mechanical construction, introduces elements of variation not to be found in the pentane and Hefner lamps.

We are not prepared to give a definite formula for the effect of water vapor on candles, but we shall put forward a tentative one. As Paterson has used the formula Candle Power $= 10 + .066\ (10\text{-}e)$, for the ten candle pentane lamp, where "e" is litres of water vapor per cubic meter of dry air and ten is the normal number of litres, so, for the B. T. S. candle in Philadelphia we should say,

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Candle Power = 1 + .0087 (9.3-e) where 9.3 is the normal litres of vapor per cubic meter of dry air.

In this connection, it is interesting to compare the average values of three kinds of candles bought as Standard Sperm Candles, obtained from three American cities of differing climates where they are used. These we shall call A, B and C. A candles were twelve to the pound; B and C candles were six to the pound. The comparison was made against an electric incandescent lamp of constant light value; and the value of each candle is the mean of all determinations made during its complete consumption. Conclusions are drawn from those tests made under similar atmospheric conditions.

Litres water vapor per cu. mtr. dry air.	A	B	C
18	.950	.924	.929
22	.936	.902	.918
23	.903	.886	.851
Average	.930	.904	.899

While a variation from the normal rate of consumption of sperm of 5 per cent. is usually adopted, there seems to be no sufficient reason why this allowable variation should not be extended to 10 per cent. in seasons of high temperature and humidity.

While the normal water vapor content of the air for the year at the place of test is 9.3 litres per cubic meter of dry air, the tests made above were in an atmosphere of higher moisture. From this knowledge gained in these, and a great many other, experiments of the effects upon candles of water vapor per cubic meter, the candles would be burning abnormally if they did fall within the time limit. Corrections, applied when the time of burning was 3 per cent. faster or 10 per cent. slower than the normal rate, gave the same value to the candle.

So long as the quiet, matured candle flame burns to the same approximate shape, there being no irregularity of wick to produce smoke (denoting incomplete combustion), it would seem that a correction applied proportionally to the sperm

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consumption error would be sufficient as a safeguard in the use of candles, without stating the per cent. limits beyond which that error must not go.

The candle is used in this country to-day more than any other standard of light, as is shown in the summary of working standards previously given. It is probable that it will yield slowly to other standards whose variations from normal are known to be within narrower limits. It possesses the advantage over all other standards of adaptability. It is easy to keep in stock, it may be received through the mail or by express, and can be carried about in one's satchel. It has been named in many contracts, franchises and leases as the unit of light measurement—"sperm candles, six to the pound, burning 120 grains per hour" still continues to be used.

While there is no official manufacturer of the standard sperm candle, it is expected by the gas companies of this country that these candles shall be obtained from certain manufacturers in England, who are believed to make them as nearly as possible in exact conformity with the Notifications last issued by the Gas Referees in 1894.

The Committee recommends that when British Standard Candles are used as the standard and unit in photometric work on gas flames, that extra care be taken in providing against drafts, while securing good ventilation, and that the average of as many readings as possible be secured. Attention is called once again to the definition of Mr. Grafton that "the light of one English candle is the amount of light emitted and maintained for at least one hour after maturing, from the combustion of 120 grains of sperm fed by a definite sized wick in a quiet but pure atmosphere."

(B) The Edgerton Standard consists of the most luminous zone of the 3-inch flame produced by burning gas through a Sugg "D" burner with a glass chimney 1¾ inches by 7 inches. This zone is 13-32 of an inch high and is emitted through a horizontal slot cut in a brass sleeve surrounding the chimney, which sleeve cuts off all other light. Either coal gas or water gas may be used as a fuel, but variations in quality of over two candles may not be permitted. Greater accuracy

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is obtained by evenly carburetting all gas used in this standard to a constant quality and storing the fuel for use in a small holder. Its value varies from 4 to 7 candles, depending upon the richness of the gas used. This is the cheapest standard. Cost, $3.75.

Defects. Fuel is usually not independent. Chimney requires frequent cleaning, and each new one should be re-standardized. The value varies with the quality of the gas furnished, which may be considerable from hour to hour.

(C) Hefner Lamp. This is a simple, wick fed, open, spire flame, independent fuel lamp. It is small in bulk and weight. Has been thoroughly studied and all corrections may be applied by formula. For constancy and reproducibility, is the equal of the best flame standards. Burns amyl-acetate, readily procurable, costing about 75c. per pint. Cost of certified lamp is $27.00.

Defects. As a unit, very few. As a working standard, many. It requires a perfectly quiet atmosphere in which to operate; flame height difficult of attainment; flame reddish color, and only .88 value in candles. Has a wick.

Bodies who have adopted the amyl-acetate lamp as a standard are: First, German Society of Gas Engineers, 1894; and second, International Electro Technical Congress, 1896.

(D) The Incandescent Electric Lamp. The type of electric incandescent lamp generally used for a photometric standard is of lower voltage than those in commercial use. It is spoken of as a "low voltage glow lamp." Such lamps when first burned give, for a constant voltage, an increasing light value. After 150 or 200 hours of steady burning, this value becomes quite constant and can then be reproduced with great accuracy. In this connection, Mr. Paterson, of the British National Physical Laboratory, says: "If the only photometric standards required were of the low voltage type, the problem might be considered as solved. A properly aged, specially prepared low voltage filament, if burnt for say ten minutes a day for five days in the week, should last two or three years without changing the half of one per cent. in candle power, provided no excess voltage is applied."

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It seems that after this period the lamp loses in illuminating value, due chiefly to the carbon deposit on the interior of the glass bulb. That properly seasoned lamps do remain remarkably constant is shown by comparisons made both by Dr. Sharp, of New York, and Dr. Hyde, of the Bureau of Standards at Washington. The Governmental Laboratories of America, England, France and Germany are equipped with such lamps of known value. If any change occurred after lapse of time, it is evident that an intercomparison would show it.

Dr. Hyde states: "Since obtaining the original lamps (from the Reichsanstalt) several comparisons of the standard of the Bureau with that of the Reichsanstalt have been made by means of seasoned incandescent lamps sent to Germany, each comparison indicating that the ratio of our unit to that of the Reichsanstalt has remained unchanged to within the errors of observation."

Dr. Sharp's comparison gave similar results.

Following are the results obtained by Lummer and Brodhun in investigating the reliability of these glow lamps as secondary standards. (See Stine, page 190.)

"Before employing the incandescent lamp as a reference light, they carefully studied its photometrical qualities. The color of the amyl-acetate flame being reddish, the color of the light of the incandescent lamp was accommodated to it by operating the lamps at a reduced voltage. Two 65 volt lamps were operated at a constant pressure of 55 volts, the electricity being supplied by a storage battery. Of the two lamps so tested, one styled R was burned continually, while the other one, L, was operated at certain intervals. They were compared against one another at frequent intervals, being placed as the two lights on the photometer bar. The data obtained were:

Hours Burned		Ratio L/R
R	L	
1	1	.8779
20	2	.8764
62	3	.8741
154	8.5	.8724
211	13.5	.8677

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In these tests especial accuracy was sought in the measurement of the current and potential of the lamps. Under their normal condition of burning, the light energy of the lamps varied nearly ten times as rapidly as the electrical energy.

The conclusion derived from these tests was that incandescent lamps under proper electrical conditions proved especially constant light sources. In addition, they possess two excellent properties: The color of their light may be adjusted to that of the compared light, and they are portable on the photometer bar without disturbance of their illuminating power."

Defects. As a working standard, the cost of installation of a storage battery, equipped for re-charging, with duplicate voltmeter and resistance coils, would be about $700. The battery must be charged by direct current; the lamps must be kept clean like a glass chimney; there must be several of these for the purpose of checking one against the other; care must be used that the lamp is not subjected to a voltage above its rated one; the voltmeter itself must be checked from time to time; the cost of re-charging must be considered, as well as renewal of batteries. For these reasons it is not a portable system.

It does not vary with the flame under atmospheric changes, and consequently is absolutely unfair as a standard in gas photometry.

(E) Elliott Lamp. The Elliott Standard is an oil lamp, of student lamp type, fed by wick, except that the wick and flame are flat. Constancy is obtained by excluding all but a definite sized portion of the flame by means of a flat screen, placed adjacent to the flame inside the chimney. The chimney is round and bulbous, so that the glass is relatively distant from the flame and so better preserved from fouling by it. It has an independent fuel supply, refined kerosene, and is quite constant in value over short periods of time. It is portable and cheap to operate. Costs $20. The oil costs from 15 cents to 18 cents per gallon, and a gallon will last about 48 hours steady burning. The lamp is the invention of Dr. Elliott, of New York. The tests that have been made are of an encouraging nature.

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Defects. It is not strictly reproducible, but is more satisfactory in this respect than either the candle or the Edgerton Standard. Has a glass chimney which requires care for accuracy. It is difficult to trim wick to proper shapeliness of flame. Six companies using it report favorably and four unfavorably.

(F) The Pentane 10 candle lamp is a portable, though rather heavy lamp (weighing 25 pounds free, or 75 to 100 pounds boxed for shipment), having an independent volatile fuel, supplied without a wick to an Argand burner, where it burns in an open, semi-directed flame, but with no glass chimney surrounding it. The fuel pressure is maintained constant by syphon action of the heavy vapor at a constant head through a constant opening. Its atmospheric correction formulæ have been determined and for constancy and reproducibility it is equal to any flame standard. It is not so much affected by drafts as a wholly open flame. Costs $80; burns pentane costing $3 per gallon; a gallon maintaining the standard flame for a period of about 48 hours continuous light.

It has been adopted as the standard of light by the following bodies: (all English)

Engineering Standards Committee,
includes a Institution of Civil Engineers.
b " " Mechanical Engineers.
c " " Naval Architects.
d Iron and Steel Institute.
e Institution of Electrical Engineers.
National Physical Laboratory.
London Gas Referees.
Institute of Gas Engineers.

Defects. Cost of fuel; difficulty of storing it; difficulty of getting it transported; and added insurance risk.

Out of thirty-two companies using the pentane lamp, five companies report them unsatisfactory.

Of each of the above standards using an independent supply of fuel, it may be said in general that about 20 minutes are required from the time of lighting until the standard is ready for use.

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(G) Jet Photometers. While Jet Photometers are used in some gas works as a criterion by which to judge of the quality of the gas made, they are not, in the true sense of the word, photometers.

The Unit.

The Unit of Light that has been generally adopted in this country is the British Standard Candle; not *a* British Standard Candle, but *the* British Standard Candle; that is, the average of all the British Standard Candles made under the Gas Referee's Notifications.

It is stated in Appendix D that the intensity of the light from the British Standard Candle since the Notifications were promulgated was deliberately changed by the London County Council. This introduces the possibility of the British Standard Candle of one decade having a different value from that of another. The unit of light should be an absolutely fixed quantity. It should be uninfluenced by atmospheric conditions, geographical location or local prejudice. The individual sperm candle is a standard and not the physical representation of the Unit. If it is used to represent exactly the intensity of the Unit, it introduces errors that cannot be gauged and that will sometimes put the manufacturer of gas of a required candle power in a false position.

While gas photometry is now about 60 years old, we have not yet adopted a scientific national unit of light. England has, and Germany has, and the English and Germans do not agree. Surely the time is ripe for the photometrists of the United States, both gas and electric, to get together on this question.

The Illuminating Engineering Society have appointed an International Committee on Nomenclature and Standards, of which our honored fellow-member of this Institute, Dr. A. C. Humphreys is Chairman. Dr. Humphreys has appointed a sub-committee to confer with the Committees appointed by the other associations interested, for the purpose of agreeing upon a value for the National Unit of Light.

It will occur to all that the definition of any theoretical unit avails little if there can be no practical way of exactly reproducing it singly or in multiple. This difficulty has been

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overcome and in the electric, low-voltage glow lamp, of exactly constant voltage, we have a custodian of the Unit that may, with care, be carried to any distance without change and can be maintained for an indefinite time.

Having adopted a unit of light, it would seem that the archives of the National Government would be the proper repository for it, just as it is for standard units of length and volume.

The Bureau of Standards, of the Department of Commerce and Labor, could furnish to the laboratories throughout the United States electric glow lamps, certified to as to their value in terms of the unit. Such laboratories, or the Bureau of Standards, could then give to the lamp used by the gas companies in their photometrical work their proper value when burning under normal condition in the terms of the unit.

The Committee recommends that the Institute take a lively interest in this subject of the determination of the Unit of Light. Our brother association, the English Institute of Gas Engineers, by resolution has made the unit of light equal one-tenth the value of the Harcourt 10 candle pentane lamp, at the National Physical Laboratory, and the other English Societies and Committees have followed suit.

The American Society of Electrical Engineers, Committee on Standards, have adopted the following rule on standards:

"Section 11, Article 142: The luminous intensity of sources of light is expressed in candle power. The unit of candle power should be derived from the standard maintained at the National Bureau of Standards at Washington, D. C., which standard unit of candle power equals 100/88 of the Hefner unit under Reichsanstalt standard condition for the Hefner."

Would such a value of the unit be satisfactory to the American Gas Institute?

The International Incandescent Photometric Commission, appointed at the time of the World's Fair at Paris, met in Zurich in 1903, and formulated plans for a separate determination in England, France and Germany of the ratios existing between the Hefner, the Carcel and the Harcourt pentane lamp.

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At their meeting in 1907, the ratio of the intensity of the Hefner lamp to that of the Harcourt was declared to be

Harcourt pentane = 10.95 Hefners.

The English Institute of Gas Engineers and the English Engineering Standards Committee declare that the English candle equals one-tenth of the Harcourt pentane lamp, or 1.095 Hefner. The American Society of Electrical Engineers have adopted the German relation of the Hefner to the candle, in which the candle equals 1.14 Hefner. In other words, the unit of light adopted by the American Society of Electrical Engineers is 4.1 per cent greater than the unit of light adopted by the English Institute of Gas Engineers.

It is this point that has been determined by the International Incandescent Photometric Commission when they adopted the relation between the Harcourt and the Hefner lamp.

APPENDIX "A."

PART I: THE ARRANGEMENT OF THE PHOTOMETER TO COMPARE VITIATION EFFECTS UPON STANDARDS.

In making the comparative vitiation tests between the gas flame and various standards, a V-shaped comparison photometer was used. This was constructed by attaching rigidly to the table of a regular 100 inch bar, another wing table of the same height, shown in plate V, Appendix A, page 488, at an angle of about 40° with it. Upon this wing a photometer track and 100 inch scale were mounted.

The lines joining the light centres on the two bars thus converged at a point; and at this point was placed a low voltage incandescent electric lamp, unaffected by atmospheric changes, which served as a standard light for both tables. It became the left-hand light on one table and the right-hand light on the other.

The two lights under comparison were placed in position, one on the opposite end of each bar from the above standard and the operator standing in the angle between the tables made his disc settings alternately on the regular bar and on the wing bar.

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The chemist made his determination of water vapor and carbonic acid content on a table placed at a point midway between the two flames being vitiated, and there is every reason to believe that in the closed room this vitiation was equally felt by both flames.

A sketch is attached showing the V photometer. Sufficient and suitable screens were, of course, placed to exclude all reflected light.

It was impossible to present to each of the two discs that position of the filament in which it had been standardized; but so long as the light in each direction was maintained constant, our purpose to find the variations of the lights tested was effected.

In some of the tests, in order to secure a higher degree of vitiation, from 12 to 15 cubic feet extra of gas per hour were burned through a Fletcher type of Bunsen burner.

PART II: COMPUTATION OF THE AMOUNT OF AIR NECESSARY TO SUFFICIENTLY VENTILATE THE PHOTOMETER ROOM RECOMMENDED.

Following is the computation of the normal vitiation of air in a room when two adults, one 5 foot gas flame and one 10 candle pentane flame are present: An adult averages 20 respirations per minute, inhaling some 30 cu. in. of air each time, thus, $20 \times 30 \times 60 \div 1728 = 21$ cu. ft. per hour of air exhaled. The air exhaled contains 4.3 per cent of carbonic acid; therefore, $.043 \times 21 = .903$ cu. ft. of carbonic acid per hour.

The average of several authorities gives .71 cu. ft. of carbonic acid per hour and .091 lbs. of water vapor per hour as the product from one person.

By figuring the products of combustion from five cubic feet of illuminating gas of average quality as shown by analysis, the carbonic acid yield would be 4.4 cu. ft. and the water vapor yield 5.1 cu. ft.

Assuming the use of the pentane standard, in each hour there is consumed one-sixth of a pint of liquid pentane, which vaporizes into .571 cu. ft. Upon combustion this produces 2.87 cu. ft. of carbonic acid and 3.43 cu. ft. of water vapor.

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Hence we have as products of combustion from the two flames and the two persons per hour:

	Carbonic Acid	Water Vapor
Two persons	1.5 cu. ft.	4.00 cu. ft.
Five cu. ft. of gas	4.4 "	5.1 "
.571 cu. ft. pentane vapor	2.87 "	3.43 "
	8.77 "	12.53 "

The purpose of ventilation in this case is to maintain the atmosphere in the photometer room of such purity that there will be present not more than six parts of carbonic acid in 10,000.

The greatest factor in the vitiation of flames is the water vapor content of the air, and it would seem that our aim in ventilation should be to keep down the excess of that. It is found, however, that a computation on the basis of keeping down the carbonic acid content is large enough to include the water vapor removal as well.

A total of 8.77 cu. ft. of carbonic acid is produced per hour. This is equivalent to that produced by $\frac{8.77}{.71} = 12.3$ persons. Kent (page 528, 1904 edition) gives 3,000 cu. ft. of external air per hour per person as necessary to maintain a purity of six parts of carbonic acid to 10,000.

Hence it is necessary to provide $12.3 \times 3{,}000 = 36{,}900$ cu. ft. of external air per hour for the room mentioned above.

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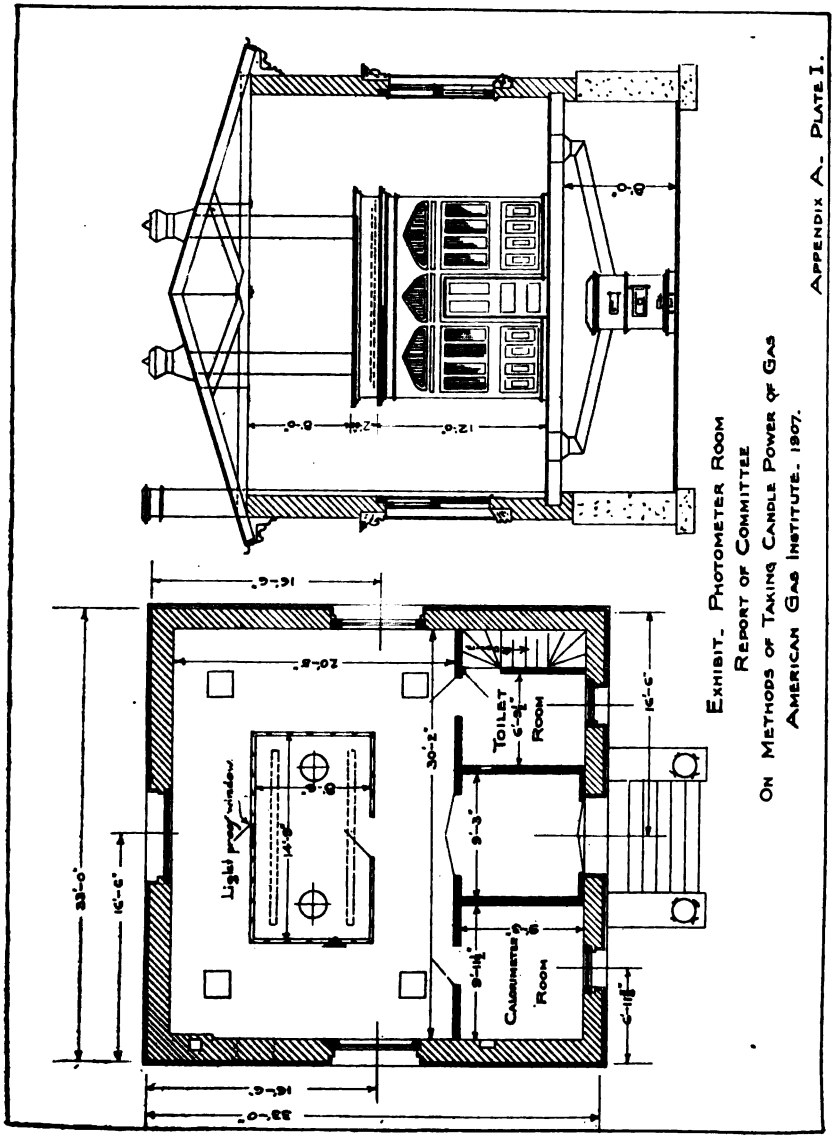

EXHIBIT. PHOTOMETER ROOM
REPORT OF COMMITTEE
ON METHODS OF TAKING CANDLE POWER OF GAS
AMERICAN GAS INSTITUTE. 1907.

APPENDIX A. PLATE I.

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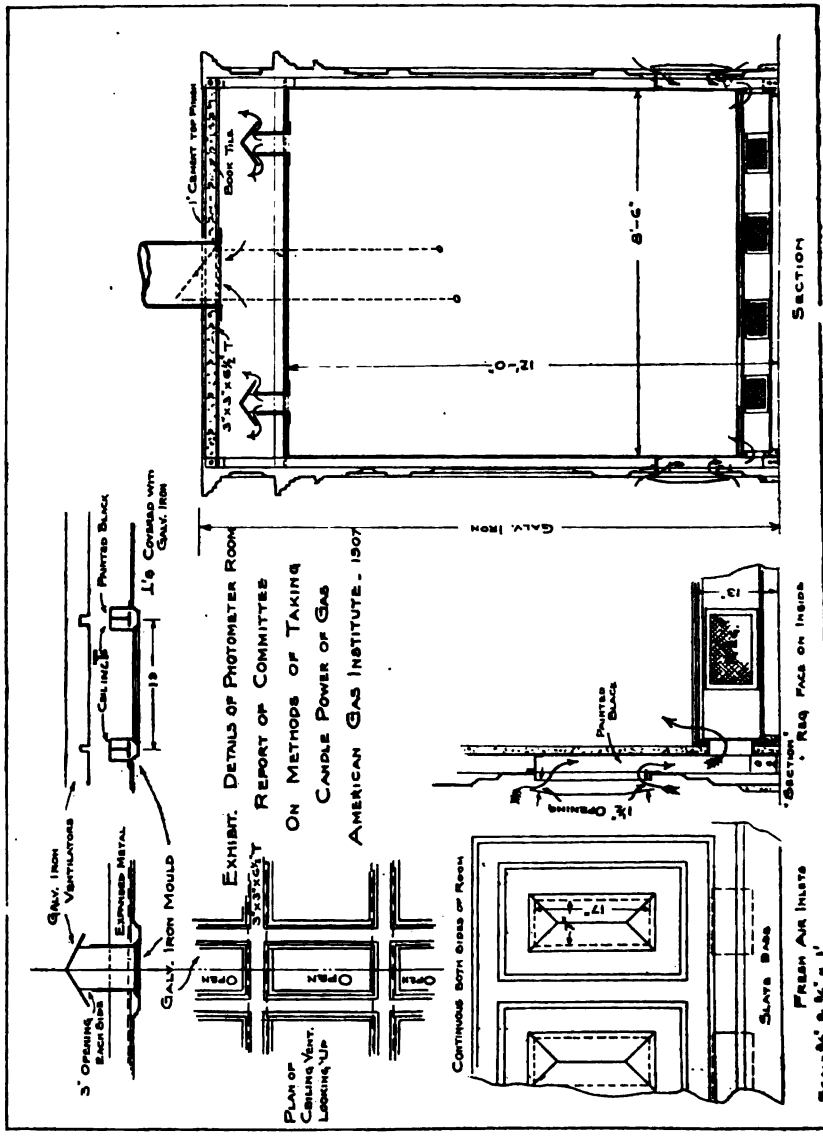

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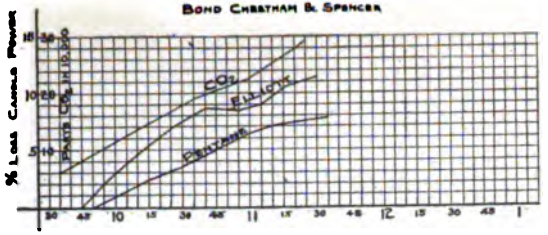

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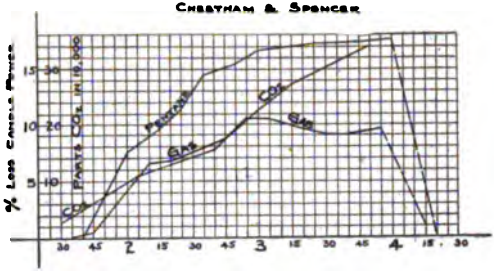

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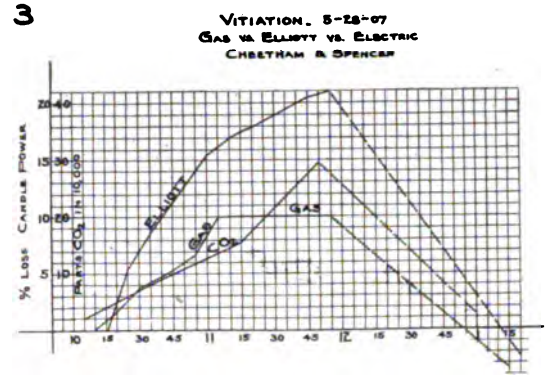

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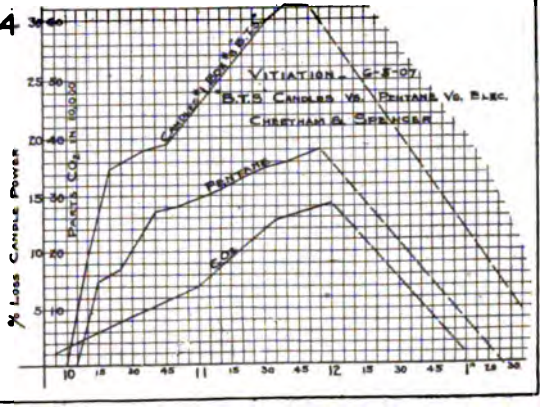

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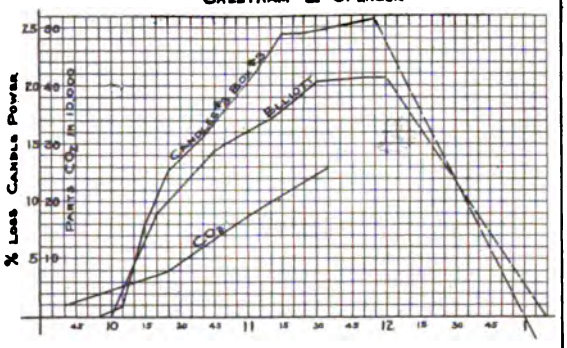
5

VITIATION. 6-6-06
"B.T.S." CANDLES VS. ELLIOTT VS. ELECTRIC
CHEETHAM & SPENCER

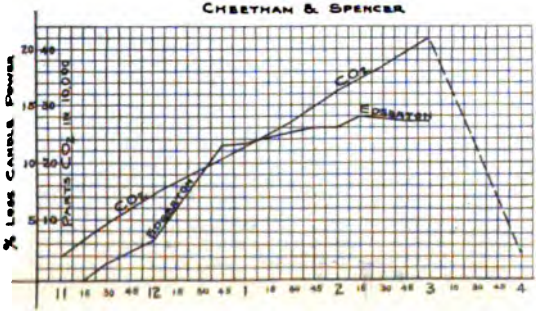


6

VITIATION. 7-10-07
SUGG "D" ARGAND VS. ELECTRIC
CHEETHAM & SPENCER

7

VITIATION. 7-11-07
EDGERTON VS. ELECTRIC
CHEETHAM & SPENCER



NOTE. CHARTS FROM 1 TO 7 MUST NOT BE COMPARED WITH EACH OTHER, BECAUSE OF DIFFERENT ATMOSPHERIC CONDITIONS ON DIFFERENT DAYS.

REPORT OF COMMITTEE
ON METHODS OF TAKING CANDLE POWER OF GAS
AMERICAN GAS INSTITUTE. 1907.

APPENDIX A. PLATE IV

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APPENDIX B.

Absorptive Action of Water Upon Benzene Vapors.

An experiment was conducted to determine the absorptive action of water at different temperatures upon the benzene vapors in a gas, such action being shown by variations in the candle power.

Arrangement of Apparatus.—Two correct one-twelfth cubic foot wet meters were used, supplied with a mixed gas from the same pipe. This gas had been subjected previously to a temperature of 35° F. The meters were filled with gas-saturated water and were placed in a water bath, the temperature of which could be controlled. The gas from meter A was led to the right end of the bar, A to R, and that from meter B to the left end of the bar, B to L. (See sketch. Appendix B, Plate 1.)

As the gas had already been subjected to a temperature of 35° F. in the distribution main, a loss in candle power in the meter and its water could not be attributed to condensation by cooling. It is due instead to the increased absorptive power for benzene vapors of the water as it was cooled.

To show this most readily, the experiment is arranged in parallel columns, the steps in the experiment being shown at the left and the results at the right under similar paragraphs.

Steps in Experiment.	Results.
1. Keep both meters at 70° F., and pass gas through both until candle power from each shows equal.	1. A constant relation was established between the candle powers from the two sources. $\frac{B}{A} = .9763$.
2. Gas being shut off from B., reduce its temperature to 40° F.; A continuing to pass gas at 70° F. Then compare c. p.	2. The candle power of B dropped 7 per cent. at once and took one hour to recover under these conditions.
3. Again raise temperature of B to 70° F. while its gas is shut off; A still passing gas at 70° F., then compare c. p.	3. The candle power of B at once rose to 9.5 per cent. above A, and returned to normal after 45 minutes.

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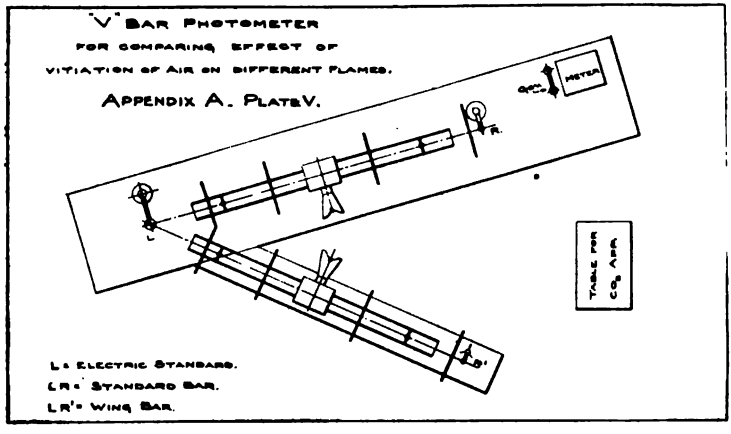
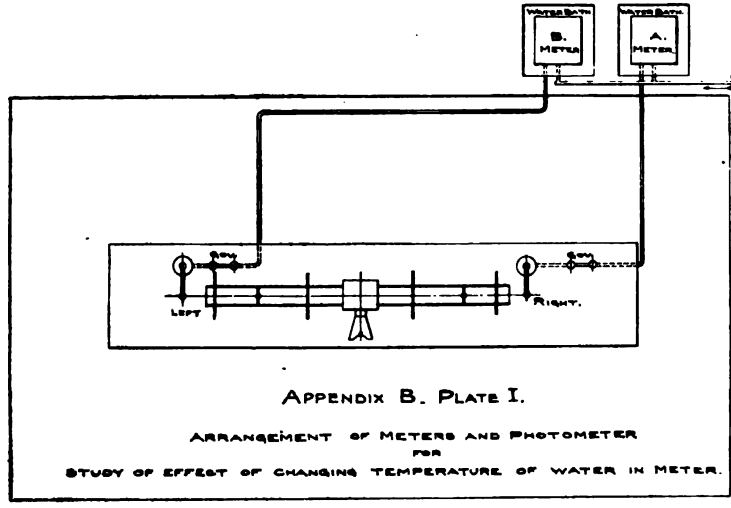
4. Gas being shut off, reduce temperature of B to 55° F.; A still passing gas at 70° F., then compare c. p.	4. The candle power of B dropped at once to 4.7 per cent. below normal; recovered in 30 minutes.





Appendix B. Plate I.

Arrangement of Meters and Photometer
for
Study of Effect of Changing Temperature of Water in Meter.

Report of Committee
On Methods of Taking Candle Power of Gas
American Gas Institute. 1907.

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APPENDIX C.

Rules to be Observed in Taking Candle Power.

1. On beginning each day's work, make a thorough inspection of all testing apparatus to see that it is in working condition. If any part is out of adjustment, correct it before making any determination involving the use of that part, and enter such fact in the daily report.

The inspection will cover the following points (if pentane lamp is used):

a. Chimney centred, and when cool, 47 mm. above burner.

b. Lamp vertical, as shown by spirit level; bob properly hung.

c. Lamp bob on 30 inch line; exposed flame at height of disc and conical shade admitting full weight on disc.

d. Pentane showing in sight glass of saturator box.

e. Meters level; no leaks at connections.

f. Water level at proper height in gauge glass and no water left in funnel.

g. Meter hands tight and without motion when gas is stopped by placing thumb over burner pillar.

h. Disc and mirror glasses clean; disc vertical.

i. Axis of rotating disc plumb above pointer.

j. Gas flame on 30 inch line; bob properly hung; flame broadside to and at height of disc.

k. Gas tip not injured or clogged and no leaks around it.

l. Meter inlet governor regulating pressure to 15/10ths.

m. Meter outlet governor in action and diaphragms pliable.

n. Centre of scale plumb above centre line of table.

o. Light screen so placed on bar as to prevent all reflected light reaching the disc, but excluding no part of flame being compared.

p. Clock and its equipment in order.

q. Hygrometer glasses clean and properly supplied with fluid.

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r. If cooling coil is used, see that temperature is normal.

2. No readings for purposes of record shall be made until the gas to be examined shall have been purging its meter for an hour; nor if the water in the meter be fresh until it shall have been saturated with gas for five hours; nor until the pentane lamp has burned at normal height for 15 minutes; nor until the test burner shall have been lighted for ten minutes.

If a portable photometer must be used and in a new location and the water in its meter has been once saturated with gas of different quality, then three hours must be allowed for the pipes and the meter to become saturated with the gas of new quality, before its candle power is taken.

3. No reading for record shall be made during less than two revolutions of the meter hand within the normal rate of flow, and with four settings of the disc, two direct and two reversed. Readings for official purposes should be made during five revolutions of the meter hand and with ten settings.

4. Quiet and silence will be preserved during the test, and after the room has been thoroughly ventilated and the door closed, sufficient time for subsidence of all drafts will be allowed before the test proceeds.

5. Pentane will be carried to the lamps in closed metal cans only. During the filling the lamps will be not lighted.

6. The temperature of the gas after its delivery into the photometrist's care for testing shall, under no circumstances, be cooled below the minimum temperature which it had reached before delivery to him.

7. Report blanks should be provided, and with ample space left for remarks. A schedule of hours for reading should be strictly adhered to.

A system to follow and an orderly habit on the part of the reader are strong guarantees of good work. To this should be added intelligence, alert to detect an unusual result and to quickly set about discovering its cause.

8. Records should be kept neatly, legibly and fully.

9. It should be the aim of every reader to thoroughly master the scientific and mechanical principles involved in the determination of correct candle power.

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We will now go through the entire process, (A) of standardizing an Elliott lamp versus candles, and (B) of reading the candle power of a flat gas flame against a ten candle pentane lamp for an official determination.

(A) Standardizing an Elliott Lamp.

1. Thoroughly clean the chimney and select the side to be exposed to the disc.

2. Place a dry wick in the burner and turn the regulator up and down through the full length of the wick to make sure that it moves freely in its channel.

3. Place the sheet brass pattern over the head of the wick and with a pair of sharp shears trim carefully to the intended form. Singe the head of the wick to free it from fluff and irregularities so as to obtain a smooth, even top.

4. Fill reservoir of lamp with Pratt's Astral Oil, invert it in place; fix the burner in position and set the wick flush with its channel.

5. Allow five minutes for the wick to fill its capillaries. In the meantime place the lamp in the position of the working standard with the wick in line between the 30 inch plumb lines and at such elevation that the centre of the diaphragm will be at the height of the disc centre.

6. Light the wick; place the burner cap and screen with chimney mounted and side selected toward the disc. Regulate the flame for a few moments until the fuel supply is uniform, when the flame height may be fixed. The flame should have an approximately level top. It should be set not more than ¼ inch above and parallel with the upper edge of the diaphragm and when so set should present a luminous whole to the diaphragm, save the blue flame at the bottom.

If it does not meet these conditions the chimney must be removed and the wick readjusted or trimmed. The tendency will be for the centre of the flame to rise too high. In this case, it may be well to cut the top of the wick even a trifle concave.

7. When the flame is correctly shaped and regulated, it should so burn for twenty minutes before the test begins, and

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a final setting across the plumb lines should be made to see that the flame is 30 inches distant from the bar centre.

8. CANDLE.—If long candles are used, one should be cut in half, its cut ends pared to a cone shape, mounted in the balance at the opposite end of the bar and lighted. These may be burning while the Elliott lamp is making ready. They should burn until the wicks project a bright red tip to the edge of the flame and there is a regular cup the full diameter of the candle, said cup being fairly dry. There must be no loose or cut strands to mar the flame's shape. The candles should then be rotated until the curvature of each wick makes an angle of 45° with the disc, and 90° with the other, one curving toward the disc and the other away from it.

9. See that the knife edges of the balance are clean and recesses free from dirt; also that edges are properly placed. See that the beam pointer does not touch the scale and that it moves freely.

10. When the candles and Elliott lamp have both arrived at the proper condition and the air in the room is pure and quiet, so adjust the candle flames that their vertical axes are 30 inches distant from the bar centre, move the beam counterweight to a position near equilibrium, and make a final delicate adjustment of the counterweight by means of the screw nuts attached to it, in such a way that the beam will soon fall. As the pointer passes the zero mark on the scale, start the timer and immediately place a 40 grain weight in the scale pan under the candles. This again raises the pointer to the top of scale.

11. Ten readings should now be made at exact intervals of one minute, beginning fifteen seconds after the clock was started.

Readings should be made by placing the disc near the point where its two sides are equally illuminated and then gradually decreasing the oscillations to the right and left of the proper position until the pointer stops at the point of equality.

Record the reading at once.

Care must be taken not to mistake differences in color of light for difference in intensity of illumination.

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After five readings the disc is reversed; the candles should burn between 9½ and 10½ minutes to consume the 40 grains. After the tenth reading, watch the pointer carefully for its falling. As the pointer passes the zero mark, stop the clock and record the time elapsed. If it be exactly ten minutes, the consumption is normal and the average reading on the bar multiplied by 2 (the number of candles), gives the value of the Elliott lamp. If the time is not ten minutes, the correction for sperm consumption is proportional, thus:

$$\frac{\text{Observed seconds}}{\text{600 seconds}} = \frac{\text{Observed reading}}{\text{Corrected reading}}$$

$$\text{or, Corrected reading} = \frac{\text{600 x Observed reading}}{\text{Observed seconds}}$$

EXAMPLE.—If the average of ten readings was 4.91 and the observed seconds were 584, then

$$\text{Corrected reading} = \frac{600 \times 4.91}{584} = 5.044$$

This is the value of the Elliott lamp in terms of the two candles. Multiplying by two, therefore, we obtain 10.09 candles as the value of the Elliott lamp. At least two such determinations should be made to assign the temporary daily value to the Elliott lamp.

When extinguishing the candle flames, first hold a piece of sperm against the red tips to quench them and then blow out. This avoids a disagreeable odor. Remove candle balance.

(B) DETERMINATION OF CANDLE POWER ON A FLAT FLAME BURNER VERSUS THE PENTANE LAMP.

1. Should the pentane lamp have been authoritatively standardized, the value so given will be used; but in case it has no value assigned, then it should be set up in the position of the working standard and its value determined in the same way as just described for the Elliott lamp, except that the value, being of a more permanent nature, should be the result of at least thirty determinations, using six pair of candles in a pure atmosphere of normal humidity.

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It ought not to be necessary to restandardize this lamp oftener than once per year, unless some change of parts or accident requires it.

The assigning of a value through candles, as above suggested, will rarely cause a wide departure from the ten candle value which is normal to the lamp, but lacking certification, and there being always a possibility of a defect in the making, this check is a helpful precaution.

2. PLACING LAMP.—The lamp, with all cocks closed, is so set in the position of the working standard, that the bob properly hung below the burner will be 30 inches from the centre of the scale; and the centre of the flame, when adjusted, will be at the height of the disc centre and the gas flame centre. The verticality of the burner and chimney is then secured by adjusting the screw legs of the tripod until the spirit level on the horizontal platform shows level in all positions of rotation. The position of the lamp should now be changed so that the burner bob is again exactly over its cross line.

When standardizing, it is well to check the accurate distance of the burner itself by turning the flame low and sighting across the plumb lines, altering the longitudinal position of the leveled lamp until the flame is visually bisected.

3. FILLING.—Open the inlet and outlet cocks on the saturator box and the drip cock at the bottom of the vapor tube. With no flame near, pour pentane from the metal bottle into the funnel until the saturator is about two-thirds full, as seen through the sight glass. Then close all cocks.

4. Remove the conical shade to see that the inlet chimney is concentric with the other and with the burner and that the mica window is turned away from the disc. If these conditions are as just said, then loosen one chimney centering screw and insert between the chimney and the burner the 47 mm. block; then tighten the screw again until the chimney is held firmly in place and remove the block.

Replace the conical shade and so rotate it that the light port opens fair toward the disc. The lamp is now ready for lighting.

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5. LIGHTING.—The regulating cock being closed, open first the outlet cock on the saturator box; then open the drip cock. At or above 60° F., it is likely that vapor pressure will have accumulated in the saturator. The drip cock will permit its release and fill the tube with vapor ready for the syphon action upon which the supply of fuel depends; and, furthermore, discharge the excess vapor below the position of the flame.

The inlet cock is then opened to establish atmospheric pressure in the saturator and the drip cock is closed. Light a match and hold over, but not touching, the steatite burner. Gradually open the regulating cock, when the vapor will ignite gently if feeding properly.

Should there at first be an excess of air in the burner, the flame will burn with a greenish centre, and as the proper proportion of the mixture is obtained, a small explosion will take place, extinguishing it. Relight at once without changing the regulating cock, when the flame will burn normally.

Its shape at first will be truly conical, but as the hot air inner-feed increases, the cone will be bulged, and its top will open into a ring.

6. REGULATING.—During the fifteen minutes while the flame is maturing, or the lamp reaching a thermal equilibrium, the flame should be, from time to time, regulated to the height of the crossbar. If it be too low, it will take longer to mature; if it be too high, it will smoke the chimney. When the flame remains steady and it is time for the reading, set its height as follows: Move the disc box near to the lamp; stand in rear of the lamp, looking first in at the mica window and then past it at the reflection of the flame front in the disc glass. Lower the flame top below the chimney. When it is perfectly quiet, slowly raise it until its reflected image shows wholly luminous at the base of the chimney. This is the position of maximum intensity of the flame. A further rise of ¼ inch will not materially affect the value of the lamp. The flame top draws to three luminous points. If the lamp is free from drafts and the air is pure, the flame height will be approximately correct when these points are at the height of the cross-

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bar on the American lamp. The lamp is now ready for use.

7. The precautions to be used before the testing of gas, as set forth in the above rules, having been followed, the flat flame is swung into the position of the test light, flame at right angles to the bar and 30 inches distant from its centre, as shown by the correct position of the bob.

8. The meter inlet pressure, being maintained constant at 15/10ths, set the rate of flow of gas so that the time of one revolution of the meter hand falls between 58 and 62 seconds.

9. Both gas and pentane flame being normal and the air in the room pure, the test may now begin.

As the meter hand passes the "5" mark on the dial, start the clock. Ten readings will be taken, reversing the disc after the first five. An interval between readings of one-half minute will be preserved, beginning fifteen seconds after the clock starts.

The clock will be stopped at the end of five revolutions of the meter hand. Observe the temperature of meter and the barometric pressure. We will assume the following data:

Average of 10 readings	=	2.17
Value of pentane lamp	=	9.93
Temperature of meter	=	72°F.
Barometer	=	29.65″

$$\text{Rate of flow} = \frac{309}{5} = 61.8 \text{ seconds}$$

Using the candle power computer, we set the temperature (72) opposite the barometric pressure (29.65) and clamp the middle scale; then 61.8 (seconds) opposite 9.93 (the value of the standard) and clamp the inner scale; then opposite the observed reading (2.17) we find the corrected candle power 23.2.

Should there be no computer, the formula for calculation is as follows:

$$\text{Corrected c.p.} = \frac{S \times R \times V}{F \times V'},$$ where S is the value of the standard, R is the average reading, V is the normal rate of consumption in cubic feet per hour at 60° F. and 30 inches barometer, V′ is the observed rate of consumption in cubic

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feet per hour at observed temperature and pressure, and where F is the multiplication factor for correcting volume at such observed temperature and pressure to normal volume.

Our data, however, has not included the rate of consumption, but instead it has shown the observed time (T') of passing a given quantity of gas as compared with the standard time (T) in which such quantity should have passed.

Therefore, $\frac{V}{V'} = \frac{T'}{T}$ and we may substitute this latter fraction in the foregoing equation, so that

$$\text{Correct c. p.} = \frac{S \times R \times T'}{F \times T} \text{ or substituting values}$$

$$\text{Correct c. p.} = \frac{9.93 \times 2.17 \times 309}{.957 \times 300} = 23.19$$

On page 181 of the Appendix to the Proceedings of the American Gas Light Association Meeting in 1905 will be found Mr. J. B. Klumpp's "Notes on the Effects of Humidity on the Pentane Lamp."

If it is desired to know the absolute illuminating value of the above gas it will be necessary to correct the value of the pentane lamp for humidity, and it may be done in the manner there shown, in which case the new value will be used in the above formula.

For the purpose of obtaining the humidity a very satisfactory wet and dry bulb is one called the "Sling Psychrometer," used by the United States Weather Bureau. It costs about $5.

As the air in a photometer room is very quiet, and as it is necessary for the correct registration of a wet bulb thermometer that the air should flow past it, the whirling motion of the above instrument accomplishes this purpose.

APPENDIX D.

Notes on English Standard Candles.

The use of candles has covered a period of 2,000 years. No other form of artificial light producer has so long and honorable a history. This is the result of the law of the survival of simplicity.

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Candles have been made in three ways:

1st. By dipping; where the wick is dipped into the melted fats, lifted and allowed to cool about the wick, then dipped again and again until the requisite diameter is obtained.

2d. By moulding; which is done in a vertical position with the wick stretched centrally in the mould.

3d. By rolling; in which a sheet of wax is bent around the wick and then rolled to give it firmness and a cylindrical shape. Church candles are chiefly of this sort.

We are mainly interested in the second process, or moulding, for this method was to be carried out to the production of the best and most scientifically made candles.

During all the periods from Biblical times to the 18th century, the fuel or body of the candle was chiefly composed of melted animal fats. It was crude and uneven in composition as was the wick also, and the flame smoked; but all lights were smoky and it was therefore no discredit to the candle that it, too, smoked, and science did not concern itself with the improvement of the candle.

Whatever the mode of manufacture, it seems that they were considered to give a fairly uniform light; so that when other light sources of higher intensity came into the field, it was natural to express them in terms of the ubiquitous candle.

In the 18th century the industry of whale fishing reached large proportions and sperm candles came upon the market, rivalling the wax and tallow candles. Scientists took an interest in lighting and began to study the action of the candle in producing light. They experimented in varying the size of the wick, in purifying or separating into its simpler elements the animal fats used for fuel, in the effect of varying the diameter and in methods of controlling the melting point by the admixture of ingredients.

They were sorely troubled, however, by the necessity for frequent snuffing of the wick in order to prevent a choking of the sperm flow by the falling of the wick ash with consequent smoking and guttering. Surely we shall look with added respect upon the candle, when we know that Gay-Lussac (1825)

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gave his attention to a cure for this trouble, recommending a flattened wick instead of a round one, in order that while burning it should curve and project the ashy tip beyond the cup. This did not wholly succeed. De Milly, in June, 1826, hit upon the scheme of washing the wick in boric acid, which at combustion produced fusion of the ash, projecting it in a bead form to the tip of the wick where total consumption took place.

In 1833, gas companies had become so active as to require regulating, and the "Lighting and Watching Act" was passed in Parliament. No mention was made of testing for illuminating power, however.

In 1847, another Parliamentary Act concerning the gas companies was passed, but no mention is made of a test for illuminating power.

In 1850, the Great Central Gas Act was passed by Parliament in which "Wax candles, six to the pound and burning 120 grains per hour" were specified for testing purposes.

It is well to state here that from 1850 dates the appearance of the paraffine candle, which, as a by-product of the petroleum industry of to-day, outnumbers all other candles.

In 1860, the Metropolitan Gas Act placed the sperm candle in the position of a standard. It, too, was specified as "Six to the pound and burning 120 grains per hour."

Clegg, in his early work on Coal Gas, in describing the photometric method of testing for luminosity, says: "One great difficulty attending all photometric experiments is the want of an invariable standard of comparison. Wax candles of a given size and weight were formerly used, but the wick of a wax candle requires to be snuffed and trimmed to make it give its maximum degree of light. . . . Spermaceti candles are not liable to the same objection, and they are now generally adopted in this country as the standard. The size mostly used is a candle of six to the pound, burning 120 grains per hour."

He gives a footnote with the Field's address where specially prepared sperm candles for photometric experiment could be obtained.

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In 1869, the paraffine candle was adopted in Germany as the Light Standard, and two years later, in 1871, its method of manufacture and use was minutely specified. A commissioner was named to supervise their production and to supply them of authentic value. It is well to note that but two years elapsed between their adoption and minute specification; whereas, with the English officials, no effort was made to better the specifications of their candles until 1893, when they were driven to it by the Gas Testing Department of the County Councils, who furnished them with standard candles, well within the lax description but yet of much higher value.

Mr. H. L. Greville says in this connection (*Journal of Gas Lighting*, 6/11/07, page 720): "Officialism represented by the County Councils (at this stage of the history) introduced a new brand of so-called standard candles which—although a legitimate standard candle—gave most disadvantageous results against the gas. . . . The candle for many years in use was the 'Miller,' and the fresh introduced was the 'Barclay.'"

In fact, the English authorities seem to have stood still in the matter of an improved standard light from 1860 to 1893, although every report of a technical or scientific body was so condemnatory of candles as should have driven them to some action. It is interesting to parallel the efforts of the English and Germans in this matter:

THE ENGLISH.

Sperm candles adopted	1860
" " specified carefully	1893
Pentane air-gas unit suggested	1877
" " " recommended for adoption 1881, 1888 and	1895
" 10 candle lamp adopted	1898
" " " " correction curves determined	1904

THE GERMANS.

Paraffine candles adopted	1869
" " specified carefully	1871

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Hefner lamp		suggested	1884
"	"	Studied, corrected and improved during several years.	
"	"	adopted	1893
"	"	correction curves determined first	1895

Complaints of irregularities in candles seem to have begun very early after their adoption, and the suggestion of Mr. Harcourt's air-gas unit, in 1877, is the first tangible result of this discontent. We shall note the attitude of various Committees towards the standard candle:

In August, 1881, a Committee of the Board of Trade on Photometric Standards report favorably on Mr. Harcourt's pentane air-gas unit, stating that "Compared with sperm candle, Harcourt's air-gas flame is exact and trustworthy as a standard of light." (See Butterfield, 1898 Ed., p. 254.)

In 1888, the Report of the Committee of the British Association, appointed for the purpose of reporting on Standards of Light, says: "The present standard candle is not worthy of being called a standard. Out of 118 tests on four standards (candles, air-gas flame, one candle pentane lamp, amyl-acetate lamp) candles gave 87 tests differing by one per cent. from the day's average. 57 differed by two per cent. and 19 by five per cent. Variations of nine and ten per cent. occurred occasionally." The air-gas unit was recommended.

In March, 1895, comes the report of the Board of Trades Committee on Photometric Standards:

"Sec. 2. . . . We have satisfied ourselves from considerations set forth in the appendix to this report, that the flame of sperm candles does not furnish a satisfactory standard, by reason of the amount of light which it affords varying over a wide range, under conditions as to the manufacture of the candle, as to its mode of use and as to adventitious circumstances attending its use, which as a whole, it is not possible to regulate and define."

The substance of the appendix referred to is (Butterfield, 1898 Ed., p. 252) that the melting point of the so-called sperm varies unavoidably and that the wick causes variations

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in the amount of light emitted. . . . The light-giving value of a candle is seriously affected by the way in which it is lighted, the length of time it has been burning, whether the cup of the candle is dry or contains melted sperm, roughness or smoothness of the wick, position of the wick toward the photometer disc and temperature of the air. . . . "It is impossible to make candles which will unfailingly burn 120 grains per hour or even within five per cent. of it. If even candles were made officially with the greatest care and supervision, there would still remain variations in the amount of light given.

For these reasons, the sperm or any other candle, however manufactured, must be considered so untrustworthy that we unhesitatingly recommend its abolition as a standard of light and the introduction of some more uniform and reliable unit."

Attention is also directed to the work done by the Dutch Photometric Commission, which published its report in 1894. As an example of original, taking-nothing-for-granted investigation this Commission's work is worthy of the study of every person interested in these matters.

As to candles: In order not to divide the source of light, they used one candle in their investigation; they determined the normal flame height to be 45 mm. and preserved as nearly that height as possible. As some light was refracted from the candle itself, as well as from the flame, they divided candles into quarters to get an average; as a candle flame is unsymmetrical, they determined the light from the broad sides and from the narrow sides of the flame and took readings for an average from the four positions by rotating the candle. They maintained the candle at a constant distance from the disc to insure constancy; as each quarter of the candle burns at a different rate, they determined the rate of combustion for each quarter; they obtained the candles tested from various authentic sources; they determined the average and the individual variations of candles.

After these careful examinations of candles, they say, (*Progressive Age,* 10/15/94, p. 405) of the English method

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of photometry then in vogue: "The principal cause of uncertainty in photometric work is the standard light employed. For example, the extreme values of an estimation by the London method may differ from one another by as much as 10 per cent. on account of variation in the actual candles employed above and below the average standard candle. The Committee has found that during ten minutes, the average light given out by a good English Parliamentary candle may exceed or fall below that of the average candle by 9 per cent. Hence, many candles ought to be employed, and this wastes much time and wearies the eye so as to make determinations unreliable; while at the same time the atmosphere in the dark room becomes vitiated and the rate of consumption of the candle varies. The observer is then tempted to meddle with the candles themselves. In Germany the flame of the candle has to be kept at a constant height and that implies meddling with the wick, while the lighting power of the candle falls in comparison with the English standard candle" (not so meddled with.)

"The English usè of the two candles cannot be recommended. . . . The average variations of the candle are 2.87 per cent. above and below; but indjvidual variations were as much as 9.82 per cent."

The foregoing weighty opinions have been cited out of numerous less important ones, to show that a better standard was felt to be necessary, and to show how conservative the British officials were in accepting one, even when it had been strongly recommended, as in the case of the air-gas flame. There seems to be no record even now that this pentane air-gas was ever officially recognized in England, though it has been indirectly recognized by the acceptance of the 10 Candle Pentane Lamp which was evaluated from the air-gas flame. With the acceptance in 1897 of the Ten Candle Pentane Lamp as the Official Standard in London, the sperm candle as an English standard closes its history.

Indeed, when one considers for a moment the candle specifications for 1894, it is clear that there would be extreme difficulty in making a candle of sperm, because the sperm

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whale is now almost unknown. So that when we import sperm candles they may be of equal average light value to the old kind, but the purity of their sperm is in question.

A strong supporter of the candle to the very end and one who said all the good that it is possible to say for the candle, was Mr. Walter Grafton, of Beckton, who, in 1898, after the adoption of the 10 Candle Pentane Lamp, published a series of articles in the *Journal of Gas Lighting* on the subject of Photometric Standards. Under date of June 14th, 1898, page 1377, we find his statement of how a candle should be burned and of the constancy of its light when so burned. It is almost enough to bolster up one's fading faith in the old reliable. We quote:

> "Having settled upon a special make of candle to use as a standard—as the one now issued and certified by the Metropolitan Gas Referees—it is next desirable to thoroughly understand what is meant by *standard light* from such a candle.
>
> . . . The question may be asked (as to light value)—What is a candle?—and the writer ventures to give an answer which experimental facts furnish. It is the amount of light emitted, and maintained for at least one hour after maturing, from the combustion of 120 grains of sperm fed by a definite-sized wick in a quiet but pure atmosphere."

He arrives at the conclusion that no test should be accepted until the candles have been burning for at least twenty minutes. He gives five series of readings, and in each the first reading, taken too early, is high; while in all the others in the different series, amounting to 44 or more, the variation is within 1 per cent. of the normal value.

Mr. Grafton again writes in 1903, in a paper before the Institute of Gas Engineers (a report of which appears in the *Journal* of June 16, 1903, page 749) entitled "Photometry and Testing." The *Journal* says: "His paper was composed of criticism of 'weak spots remaining in the present system of testing in London,' suggestion, experiment and the result of most careful work. If there is one thing more than another

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about Mr. Grafton's writings, it is that they bear the stamp of the conscientious worker. After dealing with the table photometer, he admitted that the 10 Candle Pentane Lamp is an admirable standard; but he points out certain deficiencies and loopholes for errors. He criticises the Notifications of the Gas Referees as to the method of using the lamp; and his experiments prove that variations do take place in connection with it. In order to bring the variations down to as small a compass as possible, it is necessary, he points out, among other things, that the lamp should be regulated by the outlet of the carburettor, the inlet being wide open. . . . The conclusion at which the author arrived is this: When the parts of the lamp have become thoroughly heated and the vapor regulated by the outlet tap so that the flame is 2⅞ inches in length and the chimney tube set when cold to 47 mm. above the steatite burner, the standard is worthy of being called by that name and is as reliable as it is possible to get one."

The above has been quoted to show that the most ardent and most recent English advocate of the candle as a standard, has come out in an admission favoring the pentane lamp.

While in the past few years much work has been done in determining correction factors for the Hefner and the Harcourt lamps, it seems that no such scientific care has been applied for the same purpose to the candle. It is true that Frankland and Tyndall, in 1859, had tried the effect of high altitudes or of low barometric pressure upon the candle, by burning a candle on the top of Mt. Blanc. This is at an elevation which corresponds to a pressure of 16.4 inches. The candle consumed sperm at the normal rate, but the flame became as non-luminous as that of a Bunsen burner.

Methven also did some experimenting to determine the effect of aqueous vapor on the light given by the candle. He does not evolve a law or formula, but states that at a certain fixed temperature he so varied his humidity as to produce a variation of 8.4 per cent. in the luminosity. The fact is, prob-

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ably, that we should have waited long for correction curves for any of the flame standards had not the seasoned electric light, unaffected by atmospheric changes, come to the assistance of the photometrists.

It can be seen, however, that if a certain type of standard is tested against other standards of the same type, they will be equally affected by atmospheric changes, so that any inequalities which do appear are surely traceable to defects inherent in the standards themselves and not to extraneous causes. Such a test of candles was made by Mr. Charles O. Bond, of Philadelphia, in 1900. He selected from 30 boxes of "B.T.S." 30 single candles. These were arranged in pairs and burned in accordance with the Referee's Notifications. Measurements, weighing and physical tests were also made and tabulated. It was found that the number of plaits in 4 inches of the wick varied from 33 to 37. The number of threads per strand varied from 20 to 23, the melting point varied from 111° F. to 115° F. The weight in grams varied from 36.989 to 39.663, where the standard should have been 37.8 grams. In the buoyancy test they should have sunk under an additional weight of from .13 to .26 grams; they sank under weights varying from .200 to .550 grams. The greatest importance attaches, however, to the illuminating value tests. He states: "As the lights compared are supposed to be equal, I give in the following table the average readings corrected for rate of burning, each figure given being the average of ten single readings. These figures, therefore, indicate the relative illuminating power of the pairs compared.

Column 1 shows the average of the first ten readings. Column 2 shows the average of the second ten, conditions unchanged. Column 3 is the average of Columns 1 and 2. Column 4 shows calculated readings as computed from the two preceding figures in Column 3."

"I have purposely multiplied each result by ten to put these results on the same scale of comparison as the pentane lamp, for ready reference."

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Pairs compared	1	2	3	4
1 and 2	9.39	9.07	9.230	
2 " 3	9.90	10.00	9.950	
1 " 3	10.94	11.08	11.010	10.78
4 " 5	9.15	9.41	9.280	
5 " 6	9.14	9.11	9.125	
4 " 6	9.76	9.81	9.785	9.83
7 " 8	9.20	9.37	9.285	
8 " 9	10.00	10.03	10.015	
7 " 9	10.00	10.18	10.090	10.79
10 " 11	10.26	10.41	10.335	
11 " 12	9.71	9.39	9.550	
10 " 12	9.25	9.46	9.355	9.24
13 " 14	10.15	10.20	10.175	
14 " 15	10.43	10.44	10.435	
13 " 15	10.35	10.52	10.435	10.26
		Average	9.868	

The average of column 3 will be the average relation existing among the several candles tested. Line 3, where this relation shows as 11.01, will therefore raise this average value by 11.5 per cent; whereas, line 5, where the relation is 9.125, shows a decrease of 7.5 per cent. below the average. These are the widest individual variations.

At the time when the Referees issued their instructions for the better manufacture of candles in 1894, Dr. E. G. Love, of New York, published an article on Standard Candles on March 5, in the *American Gas Light Journal*. He stated that it had been his custom for several years past to make a record of the physical measurements and characteristics of the different batches of candles used in the Testing Stations in New York. He secured samples from six different lots at the time mentioned and made a thorough tabulation of the extent to which they complied with the New Notifications. He found considerable variation in each of the following particulars:

Number of threads in a strand of wick.

Number of plaits in 4 inches of wick.

Weight of 12 inches of wick.

Weight of ash from wick.

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Melting point of the spermaceti.
Weight of entire candle.
Buoyancy of individual candles.
He concludes as follows:

"The foregoing may be taken as representing the standard candles at present obtainable in this market; and it remains to be seen to what degree of perfection they may be brought under the Referee's instructions. Certainly this is a move in the right direction and undoubtedly it will result in considerable improvement, and thereby conduce to the moral rectitude of photometrists." . . "It is rather surprising that no effort looking towards more uniformity in the manufacture of standard candles should have been made until there was a fair prospect that before long they would be replaced by some other photometrical standard."

Following Dr. Love's paper and for several years after there was a demand in this country for more uniform candles and the general impression seemed to be that the candle in use was of too high a value. The American Meter Company were large importers of candles for testing purposes, and to comply with this demand, they wrote to the English house from whom candles were obtained, voicing the demand for the Standard Candle made according to the Referee's Notifications. The reply stated that the English Standard Candle manufacturers had endeavored to live up to those requirements and had found it impracticable to do so; that the candles had not improved in uniformity in consequence of the new method, and that in short, the "By-law was a dead letter." It is well to recall the final word of the Committee on Photometric Standards at about this same date, in which this same view is borne out.

In 1898-9 the subject of municipal testing of gas in the City of Philadelphia brought forward the question of the standard candle once more and the Chief Inspector, Dr. N. Wiley Thomas, undertook to make candles meeting the exact requirements of the Referees in all particulars. He states:

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"While we followed minutely the requirements of the British Standards and were fairly successful in the preparation of a 'practical' candle, we were unable to eliminate its well-known variability in the every-day work of the photometer room."

WILLIAM H. GARTLEY, *Chairman*,
EDWARD G. COWDERY,
ALTEN S. MILLER,
WILLIAM E. MCKAY,
WALTER R. ADDICKS,
WALTER B. CLINE,
PAUL DOTY.

(For discussion of above Report see page 528.)

THE PRESIDENT: We arranged yesterday to take up the report of three committees sometime between half-past ten and twelve o'clock. I think we may reasonably begin taking up those committee reports, and I will call for the report of the Committee on the Next Place of Meeting.

REPORT OF COMMITTEE ON THE NEXT PLACE OF MEETING.

MR. IRVIN BUTTERWORTH: Mr. President, the report of our committee is very short. We met and decided to recommend that the Institute meet next year in Detroit, Mich.

THE PRESIDENT: Gentlemen, you have heard the report of the Committee on Next Place of Meeting, that we meet next year in Detroit, Mich. Are there any remarks?

MR. E. G. PRATT: Mr. President, I move the adoption of the report of the committee.

Motion seconded.

THE PRESIDENT: It is moved and seconded that the report of the Committee on Next Place of Meeting be adopted. Any remarks? Those in favor please say "Aye." Contrary, "No." Carried. The Institute will meet next year in Detroit, Mich.

I call for the report of the Committee on President's Address. I will ask Mr. Pritchard if he will kindly preside during the presentation of the report of the Committee on President's Address.

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(Mr. C. F. Prichard assumes the chair.)

THE VICE-PRESIDENT: I will call upon the Chairman of that committee, Mr. Lynn, if I remember.

MR. LYNN: Mr. President and Gentlemen, the Committee on President's Address report as follows:

REPORT OF COMMITTEE ON PRESIDENT'S ADDRESS.

Favorable action has already been taken by the Institute on the changes in the Constitution recommended under the President's plan to enlarge the effective work and to extend the influence of the Institute; the prompt approval of these preliminary steps is sincere assurance that the Institute is in hearty accord with the sentiments of the address.

The reiteration of the claim for just recognition of the work performed and the progress accomplished in our industry, the refutation of false detraction, the fair statement of our duty to the people whom we serve, and the confident anticipation of appreciative co-operation of the public, command the attention and convincingly claim the endorsement of the Institute.

In this address, the high plane of thought, the broad survey of our future work, the clear exposition of our present purposes, the enthusiastic devotion to professional and to civic duties, must prove a lofty inspiration to every member of the Institute, and we rejoice that the Institute begins its career by the establishment of a standard that thought may improve, and experience may perfect, but time cannot impair.

J. T. LYNN,
W. E. MCKAY,
R. B. BROWN.

THE VICE-PRESIDENT: Gentlemen, you have heard the report of the Committee on President's Address: what is your pleasure?

DR. HUMPHREYS: Mr. President, I move its adoption.

Motion seconded.

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THE VICE-PRESIDENT: Are there any remarks? If not, all those in favor say "Aye." Contrary minds "No." It is unanimously adopted.

(President Walton Clark resumes the chair.)

THE PRESIDENT: The next business is the report of the Nominating Committee. Is the Committee ready to report?

REPORT OF NOMINATING COMMITTEE.

MR. LATHROP: Mr. President and Gentlemen, your Nominating Committee recommend as follows: For President, Dr. Alexander C. Humphreys; for First Vice-President, Mr. William H. Bradley; for Second Vice-President, Mr. William A. Baehr. For Members of the Board of Directors, Mr. Walton Forstall, Mr. E. G. Cowdery, Mr. K. M. Mitchell, Mr. James H. Jourdan and Mr. J. Arnold Norcross.

Pursuant to a request from the Secretary of the Board of Directors, this Committee requests further time before recommending a name for the office of Secretary and Treasurer.

Respectfully submitted,

ALANSON P. LATHROP,
RICHARD REES,
I. C. COPLEY,
R. M. SEARLE,
Nominating Committee.

MR. LATHROP: The other member of the Committee desires, as I understand, to present a still further report.

MR. S. J. FOWLER: Mr. President, it is with sincere regret that I find myself unable to sign the majority report of the Nominating Committee. But at the beginning of its career it seems to me to be most important that this association should be started right.

I cannot accede to the principle of choosing the officers of the Institute except from among those who have already done

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the work of its Board of Directors and have then become Vice-President.

I therefore put in nomination
For President, Charles F. Prichard.
For First Vice-President, H. L. Doherty.
For Second Vice-President, A. C. Humphreys.

For Directors, Walton Forstall, E. G. Cowdery, K. M. Mitchell, J. H. Jourdan, J. A. Norcross.

SAMUEL J. FOWLER,
Minority of Nominating Committee.

MR. COWDERY: Mr. President, I move you that the report of the majority of the Committee be accepted by this Institute as the unanimous nominations of this body.

MR. PAUL THOMPSON: Second the motion.

THE PRESIDENT: Gentlemen, you have heard the motion.

MR. NETTLETON: Mr. Chairman, I would like to make an inquiry as to what the acceptance of the report of the Nominating Committee carries with it? Will the acceptance of the report carry with it the election of the officers?

THE PRESIDENT: I understand that the acceptance of the report will at once bring the matter before the Institute to vote upon, and as I understand a motion would probably be made to instruct the Secretary to cast the ballot of the Institute for the members named in the majority report. I assume that such would be the procedure.

MR. NETTLETON: I would like to give notice that if it comes to that point, I wish to enter an objection. I would like to have a ballot taken for officers. Whichever way is the quickest and shortest way to reach that result I am in favor of.

THE PRESIDENT: The motion before the house is that the report of the majority of the Committee be accepted.

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MR. D. MCDONALD (of Louisville): Mr. President, I move to amend that motion. I move that we accept the minority report.

Motion seconded.

THE PRESIDENT: The motion before the house is on the amendment to Mr. Cowdery's motion, the amendment being that we accept the minority report in place of the majority report.

MR. EGNER: Mr. President, I would, under all ordinary circumstances, consider it a great privilege to nominate Dr. Humphreys for the Presidency, and next to that to second such a nomination, and next to that to vote for him, but I believe that the point made by Mr. Fowler is well taken, and I certainly wish to second Mr. Fowler's report also. I believe that we could not have a more representative gentleman at the head of the Institute than Dr. Humphreys, but at the same time I believe that the report made by Mr. Fowler carries much weight with it, and under the circumstances, I favor the election of Mr. Prichard and second Mr. Fowler's report.

THE PRESIDENT: The difference between the two reports is on the executive officers only. The Board of Directors remains the same in both cases.

MR. COPLEY: I rise for a little information. Is there anything, in the judgment of the Chair, in the Constitution or By-laws of this Institute that would prevent our taking a ballot as between the two candidates or two tickets that are now in the field. I would like to ask the judgment of the Chair.

THE PRESIDENT: The Chair would rule that in the absence of unanimous instructions to the Secretary to cast the ballot of the Institute for any person named that we must take a ballot of the enrolled members.

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MR. COPLEY: I hope very much that both gentlemen will withdraw their motions.

MR. MCDONALD: I withdraw my motion.

A MEMBER: I will withdraw my second.

MR. COPLEY: I hope Mr. Cowdery will do the same.

MR. COWDERY: I prefer not to withdraw it.

MR. MCDONALD: I am bound to bring the matter to a vote, if I can, and if Mr. Cowdery will not withdraw his motion and let the matter come up as Mr. Copley has indicated, I will reinstate my own motion to amend by accepting the minority report. I cannot see why this convention should not be permitted to vote for all of its officers in a lump instead of voting for them by ballot as the Constitution provides.

A MEMBER: I move as a substitute that both reports be received, that the nominees in both reports be declared the nominees, and that we proceed to ballot for the officers. Let the Institute make its choice from the two lists.

MR. THOMPSON: Mr. President, I would rise to a point of order, and ask that in considering the report of the Nominating Committee, whether the Committee should not present one name for each vacancy, and that there could be no minority report from the Nominating Committee. The Constitution and By-laws provide that any twenty members of the Institute not in accord with the recommendations of a majority of the Nominating Committee have the right to nominate whomever they like, but so far as the Nominating Committee is concerned, the report of a majority of them is the report of the Nominating Committee, and there can be no minority report from that Committee.

MR. A. E. FORSTALL: I was largely instrumental in drawing up that Constitution, and the idea in my mind was that there should be two ways of putting the question which is apparently at issue here; one, through the report of the Nom-

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inating Committee, and the other by a special nominating committee of twenty members, any twenty members who wished to put in another list. It seems to me that under the Constitution that is the only way that two tickets can be placed in the field.

THE PRESIDENT: The Chair will rule that that interpretation of the Constitution is correct. The Nominating Committee should present their report through its Chairman, and any twenty members entitled to vote may constitute themselves a nominating committee and present their names, if they wish. The minority report under that ruling is not before the house.

MR. NETTLETON: In view of that ruling, Mr. President, I desire to present the report of such a special nominating committee, signed by more than the requisite twenty names.

THE PRESIDENT: Will you read the nominations, please?

MR. NETTLETON: We have copied the wording of the Constitution.

In accordance with section number 32 of the Constitution we hereby present the following list of the active members whom we recommend as officers for the ensuing year:

For President, Charles F. Prichard.

For First Vice-President, H. L. Doherty.

For Second Vice-President, A. C. Humphreys.

For Directors, Walton Forstall, E. G. Cowdery, K. M. Mitchell, J. H. Jourdan, J. A. Norcross.

Respectfully submitted,

Charles H. Nettleton,	Ira A. Miller,
William E. McKay,	Edwin E. Witherby,
Samuel J. Fowler,	L. B. Johns,
D. J. Collins,	W. H. Merritt,

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F. H. Sargent,	Charles D. Lamson,
J. T. Lynn,	Frank D. Moses,
John Dell,	R. M. Kellogg,
Joseph E. Nute,	J. R. Huntting,
W. H. Gardiner,	W. A. Wood,
Donald McDonald,	W. H. Frost,
Walter F. Norton,	C. H. Nutting,
Charles A. Learned,	E. A. Wakeman,
Waldo A. Learned,	M. R. Bump,
Albert M. Barnes,	Frank K. Lane,
Charles H. Gifford,	J. P. Kennedy,

Special Nominating Committee.

THE PRESIDENT: Will the Secretary instruct the President whether the gentlemen whose names have just been read by Mr. Nettleton are twenty or more in number, and whether the gentlemen are members of the Institute. Possibly while the Secretary is looking that up we can proceed with the motion. The motion is before the house. The motion before the house is that the house adopt the report of the majority of the Nominating Committee.

MR. WALTON FORSTALL: Mr. President, I would move to amend that motion by instructing the Secretary to cast the ballot of the members of the Institute for the names presented by the Nominating Committee for which no other nominations have been made or presented, and which have been named on the other ticket; that is, those who have been named for Directors.

MR. W. A. WOOD: Mr. President, in regard to the nomination of Mr. Bradley, I have just been talking with him, and while he appreciates the honor which the Committee has conferred upon him by placing him in nomination he says it would be impossible for him to accept the nomination or to serve, even if he should be elected. He wished me to make that statement.

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THE PRESIDENT: I do not know what we can do now about it.

I think we will have to wait for the Secretary to instruct the Chair as to whether these nominations are in regular form before we proceed to any vote on any resolution. We must be very regular about this, but I have no doubt it is all right.

SECRETARY DUNBAR: Mr. President, I have to report that there are thirty signatures on this list, more than twenty of whom I can vouch for as being active members of the Institute entitled to vote.

THE PRESIDENT: Gentlemen, there are now before the house two sets of nominations, the nominations presented by the Nominating Committee, and the nominations presented by the gentlemen whose names were read by Mr. Nettleton. They differ only in the names of the men presented for President, First Vice-President and Second Vice-President. In all other respects, they are the same. Now we have before us Mr. Cowdery's motion, that the Institute adopt the report of the Nominating Committee, meaning the nominating committee formed by the Board of Directors, as I understand it.

MR. BOARDMAN: Mr. President, I would like to amend Mr. Cowdery's motion by instructing the Secretary to cast the ballot for those persons named about which there is no contest, that is, for the Board of Directors. I understand that both have submitted the same names. I think we can simplify matters in that way, and get through with the ballot much quicker, and especially when you go into the ballot, the tally will have to be taken on each name, and if this is passed it will eliminate just that much from the work. Therefore, for the purpose of simplifying that, and getting through with the ballot quicker, I would offer this amendment.

Amendment seconded.

THE PRESIDENT: Gentlemen, it has been moved and seconded that Mr. Cowdery's motion be amended to this

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extent: to instruct the Secretary to cast the ballot of the Institute for the Directors who have been nominated by both sides, that is, for Walton Forstall, E. G. Cowdery, K. M. Mitchell, James H. Jourdan and J. A. Norcross to serve as directors during the ensuing year. That amendment has been seconded. That amendment being carried, the question will then come on Mr. Cowdery's motion that the Institute accept, or adopt the report of the Nominating Committee. Gentlemen, are you ready for the question on the amendment?

MR. LYNN: I move that the report of the minority also be accepted. There is nothing in our Constitution that says there shall not be a minority report, and as I understand parliamentary law, the minority of any committee has got the right to put in a report at any time.

THE PRESIDENT: May I suggest to Mr. Lynn that in order to simplify the parliamentary situation that motion be withdrawn for the present. Will you not consent to withdraw that, as I think by so doing it will greatly simplify the situation.

Motion presented by Mr. Lynn withdrawn.

THE PRESIDENT: The question then is on Mr. Boardman's amendment to Mr. Cowdery's motion which you have heard, gentlemen. Are there any further remarks? Those in favor will please say "Aye." Contrary minds, "No." It is unanimous. The Secretary will please cast in accordance with the instructions of the Institute the vote of the Institute for Walton Forstall, E. G. Cowdery, K. M. Mitchell, James H. Jourdan and J. A. Norcross to serve as Directors for the ensuing year.

The President appointed Mr. W. H. Gardiner and another member to act as tellers to receive the vote.

SECRETARY DUNBAR: In accordance with your instructions, Mr. President and Gentlemen of the American Gas Institute, I cast the vote of the members present for Walton

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Forstall, E. G. Cowdery, K. M. Mitchell, James H. Jourdan and J. A. Norcross to serve as Directors of this Institute.

MR. GARDINER: Mr. President, we beg to report that the Secretary has cast, as instructed by the Institute, the vote of the Institute, and thereby electing Walton Forstall, E. G. Cowdery, K. M. Mitchell, James H. Jourdan and J. A. Norcross as Directors of the Institute.

THE PRESIDENT: Gentlemen, as instructed by you, the Secretary has cast the ballot for the gentlemen named, and I therefore declare Walton Forstall, E. G. Cowdery, K. M. Mitchell, James H. Jourdan and J. A. Norcross elected to serve as Directors for two years.

MR. COWDERY: Mr. President, I did not understand that under the Constitution the Secretary could cast the ballot; as it now appears otherwise I move that the report of a majority of the Committee be accepted, and that the Secretary be instructed to cast the ballot of the Association for the names mentioned, for President, First Vice-President and Second Vice-President.

MR. DONALD MCDONALD (of Louisville): Before that motion is put, Mr. President, I want to remind all the members here that the Institute itself is much bigger and more important than any man or any set of men in it, and I do not know of any way in which a defeated candidate can get any satisfaction except by a cheerful submission to the will of the majority, whatever that may be. Where there are two candidates for the same office, somebody is bound to be defeated.

Now gentlemen, do not let us have any other kind of a fight here than that which, however it may turn out, will redound to the benefit of this Institute. The members of this body who are in nomination on both tickets are men whom we all delight to honor, but we cannot elect them both to the same office. We cannot honor them as perhaps many of us would like to, but this fight, in view of that fact, ought to be con-

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ducted in such a spirit that whoever is defeated will feel that in the election of the others there is nothing derogatory to himself or to the best interests of the Institute. We shall have a good set of officers either way. In my opinion, the only fair way to settle the question is to take a vote, by ballot, as the Constitution provides.

MR. RICE: Mr. President, as I understand the rules, if there is one objection to this motion which has just been made, a ballot will be in order.

THE PRESIDENT: I so understand it. That motion cannot be put unless there is unanimous consent to the Secretary so acting. If there is one objection to this motion the matter is just where it was before, and there has been no election and will be none until you take a ballot.

MR. NETTLETON: I object then. If it is only necessary to make an objection, I object.

THE PRESIDENT: Mr. Nettleton states that he will object to that action on Mr. Cowdery's motion. The Chair will then proceed to put the motion which is before the house. The question is on Mr. Cowdery's motion. Are there any further remarks? Those in favor please say "Aye." Contrary, "No." The motion is lost.

We now have before the house two sets of nominations for President, First Vice-President and Second Vice-President.

MR. I. C. COPLEY: Mr. President, I move that the Institute now proceed to determine by a written ballot its choice for President, First Vice-President and Second Vice-President.

Motion seconded.

THE PRESIDENT: It is moved and seconded that the Institute now proceed to determine by written ballot its choice for President, First Vice-President and Second Vice-President. The Chair would suggest that if the motion is carried that we

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establish the polling place outside of this room with the three tellers that the Constitution provides for, and that the voting place be open between the hours of twelve and half-past one for the casting of the vote. That will expedite the business and give everybody an opportunity to vote as he goes out or in at any time between those hours.

MR. THOMPSON: Mr. President, I offer as a suggestion that inasmuch as the time from twelve to half-past one is but ninety minutes, and there are three hundred members here to vote, it is going to make it a very short time within which the ballot will have to be taken. After the ballot is taken, the tellers will have to count the votes, and the Institute will reassemble, I suppose, at the usual hour, two o'clock. Now I understand that the Secretary will have to be there with a certified list of the members for the purpose of seeing that each member who offers to vote is properly qualified to cast his ballot, and it does not seem to me, therefore, that an hour and a half is a sufficient time for all of the members. I think it would be better if the vote was taken now.

THE PRESIDENT: I made that suggestion simply as a suggestion. There is no motion to that effect before the house. Mr. Copley's motion is now before you, which is that the Institute now proceed by a written ballot to make its choice for President, First Vice-President and Second Vice-President. If that is carried, it means that the Institute must proceed at once to take the ballot. Are there any remarks? Those in favor of the motion to proceed to vote for President, First Vice-President and Second Vice-President will please say so. Contrary minds, "No." It is carried.

MR. WOOD: Mr. President, wouldn't it be well just at this time to have a statement made as to just who is entitled to vote? I think there is some doubt on that point.

SECRETARY DUNBAR: Only the active members of the Institute are entitled to vote, excepting those who are in arrears for dues, for one year or more.

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MR. LYNN: Have we got to have a roll-call?

A MEMBER: I move that the Secretary call the roll of those who are in good standing.

THE PRESIDENT: When the ballot is taken, no one will be allowed to vote except those who are in good standing. We have decided to vote by ballot. We shall have to follow the Constitution. The only way that the matter can be decided now is by ballot. The members will please come up in front of the tellers and the Secretary and express their preference.

MR. COPLEY: Mr. President, my motion provided for a written ballot.

THE PRESIDENT: And also the motion that we have adopted provides for a written ballot.

The Secretary will call the roll, and when a member's name is called, he will come forward and make his presence known to the Secretary so that his name can be checked, and then deposit his ballot with the tellers.

A MEMBER: Mr. President, I would suggest as a matter of expedition in taking this ballot that the names of the three candidates be written on one ballot, and that the Secretary call the roll of the members entitled to vote, and that those candidates having the highest number of votes for each office be declared elected:

THE PRESIDENT: The ballot will have to be counted by the tellers as the Constitution provides. Such a procedure would be unconstitutional.

MR. SEARLE: Mr. President, am I right in understanding that owing one year's dues is enough to disqualify a voter?

THE PRESIDENT: The Secretary has made an announcement covering that point.

SECRETARY DUNBAR: I will state that the Treasurer has a list of delinquents up to the first of September of this year.

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There have been a few that have paid since that time, and who were on that list. Should any voter present himself who claims to have paid since the list was made up, those cases can be adjusted as they occur.

MR. EGNER: May I suggest, Mr. President, that the names of the candidates be posted so we could see them—the names on the two opposing tickets?

THE PRESIDENT: That has been arranged for, as I understand, and they will be placed up here at my left.

MR. WALTON FORSTALL: Mr. President, it seems to me it would be a great waste of time if we have to take this ballot during the time allotted for the regular business of the convention. In other words, I do not see why we could not arrange to have this ballot taken in some such way as was suggested by the President and have the business go on at the same time. The idea of voting here and taking up a lot of time of the Institute seems to me to be entirely unnecessary.

THE PRESIDENT: In view of the action already taken we are now engaged in taking the vote, and it is too late for that.

The house will now proceed to ballot.

The Chair appoints Mr. Waldo Learned, Mr. R. B. Brown and Mr. Donald McDonald tellers of the election.

Any misspelling of a name or the omission of a title, or misstatement of a title will not necessarily invalidate a man's vote. It will be necessary to note on the ballot the name of the office for which the man is voting and the name of the man whom he desires to fill that office.

MR. WALTON FORSTALL: Mr. President, I rise to a point of information. Do I understand that each ballot should contain the name of just one man, or should all of the names be put upon one ballot in the way you have indicated?

THE PRESIDENT: Each ballot should contain the name of the man whom you choose for President, the man whom you

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choose for First Vice-President, and the name of the man whom you choose for Second Vice-President; all three names on one ticket.

MR. COWDERY: Mr. President, I notice that Mr. W. H. Bradley is a candidate for Vice-President, and I understand that he would not accept if elected. Is it necessary to do anything about that?

THE PRESIDENT: That is a matter in the hands of the Nominating Committee. We have nothing from the Nominating Committee on that subject. Mr. Bradley has been nominated for First Vice-President by the Nominating Committee, and the other nomination for First Vice-President is Mr. Doherty. That is all so far as this house knows.

The Chair is informed that there is some confusion among the members of the Institute as to the candidates. The candidates before the house for President are Alex. C. Humphreys and C. F. Prichard. Any man may vote for either of these but may not vote for anyone else. The candidates for First Vice-President are Mr. Bradley and Mr. Doherty. Any man may vote for either of these gentlemen but may not vote for anyone else. The candidates for Second Vice-President are W. A. Baehr and Alex. C. Humphreys. Any man may vote for either of these men for that position and may not vote for any other man for that position.

MR. COWDERY: It is suggested that we may both elect a President and a Vice-President at the same time in the person of Dr. Humphreys, he being a candidate for the two positions.

THE PRESIDENT: I wish to announce that the Treasurer is in the corridor, and will receipt for dues at any time for any man who is disqualified for not paying his dues.

The Chair will make this ruling: the names of the active members entitled to vote will be called, and any man who has not voted, not here, or not hearing his name called, or who for any reason has not voted, will have the opportunity to vote

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from now until the time when the tellers conclude their count. The tellers will remain in this room, and they will report to the Institute at two o'clock. Anybody who has not voted will have the right to vote at any time from now until the tellers conclude their count.

In the meantime the meeting is declared adjourned to meet at two o'clock.

SECOND DAY—AFTERNOON SESSION.

Convention called to order at 2 p. m., President Clark in the chair.

THE PRESIDENT: I am sorry to have to open the meeting with so few present, but we have a great deal to do. The first business is to hear the report of the tellers appointed to count the ballot taken this morning.

MR. W. A. LEARNED presented the report as follows:

To the American Gas Institute.

Gentlemen: We, the tellers appointed to receive and count your votes for President, First Vice-President and Second Vice-President do report as follows:

First. That we finished our count at 1:35 p. m., and having received the votes of all persons offering to vote, unanimously declared the polls closed at that time.

Second. That for the office of President Mr. A. C. Humphreys received 139 votes; Mr. C. F. Prichard received 128 votes.

For the office of First Vice-President, Mr. H. L. Doherty received 149 votes; Mr. W. H. Bradley received 111 votes.

For the office of Second Vice-President, Mr. W. A. Baehr received 143 votes; Mr. A. C. Humphreys received 109 votes.

Respectfully submitted,

W. A. LEARNED,
R. B. BROWN,
DONALD MCDONALD.

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THE PRESIDENT: From the report of the tellers, it is evident that Dr. A. C. Humphreys is elected President of the Institute for the ensuing year; that H. L. Doherty is elected First Vice-President of the Institute for the ensuing year, and that W. A. Baehr is elected Second Vice-President for the ensuing year.

MR. DONALD MCDONALD (Louisville): Mr. President, I move that the election of all those gentlemen be made unanimous.

Motion seconded.

MR. CHARLES F. PRICHARD: Mr. President and Gentlemen: To the philosopher there is pleasure in almost everything, so if this be defeat there are pleasures to be derived from it. That ranking first of all is the pleasure that comes to me from receiving the loyal support that I have had from those who have worked and voted for me. To those who value friends, the warm hand-clasp and kindly smile means pleasure, the equal of which is to be had from no other source. Next there is the pleasure that comes from any good race. There is pleasure and excitement even if you are "distanced," there is pleasure if you are in the "also ran" class, and there certainly is pleasure in a friendly competition like this when you know you have given your opponents the run of their lives for their money. (Laughter.) There is pleasure to be had as expressed by paraphrasing the poet's line, "It is better to have run and lost than never to have run at all." There is pleasure, if one must be defeated, in being defeated by a man of Dr. Humphreys' ability, and finally, but not by any means least of all, there is great pleasure in the privilege it earns me of moving that his election be made unanimous.

MR. E. G. COWDERY: I second the motion.

THE PRESIDENT: Gentlemen, it is moved and seconded that Mr. Humphreys' election to the office of President be made unanimous. Recognizing, as I do, that there is perhaps a question whether under the Constitution we can properly do that, especially if there is objection, still I believe it is the

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desire of the Institute that this motion be put and recorded. Therefore, if there is no objection, I will put the motion. Mr. Prichard moves, and the motion has been duly seconded, that the election of Mr. Humphreys to the office of President be made unanimous. Those in favor please arise. You will be seated. Those opposed. I am happy to say Mr. Humphreys' election has been made unanimous.

DR. A. C. HUMPHREYS: Gentlemen of the Association: I wish to thank you very sincerely for the honor which you have done me, but in accepting this office I must have regard to the responsibilities which go with it, as well as the honor. I wish to say, therefore, with that responsibility before me, and especially at this particular time, I did not seek the office. Now, however, that I have been elected to it, I shall endeavor to serve you to the best of my ability. I believe that we have come upon a time when this association as the representative of the gas associations and gas interests of the United States has a very distinct and a very weighty responsibility laid upon it, and a large share of that responsibility must be borne by the executive. As your representatives, the Board of Directors and the officers must take up and carry that responsibility; but, primarily, the responsibility rests upon every member of the association and to them the officers and directors must look for support.

Before closing let me express my very deep appreciation of the gracious way in which Mr. Prichard has brought forward a motion to make my election unanimous. Mr. Prichard is a man for whom I have for many years held a very high regard, and he knows, as I know, that there has been nothing personal in this contest. I have been only too glad to say that to my friends, and that whatever the outcome was to be it had nothing whatever to do with the friendship that existed between us. (Applause.)

THE PRESIDENT: I feel that I express the sentiment of every member of the Institute when I say that the officers-elect have been elected in opposition to some of the very best

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men, and most able and well-intentioned men in this Institute, and they must feel that the burden is heavy upon them. When we meet a year from this time and receive the report of what the new administration has done during the coming year, the then past year, many of us will contrast it in our minds with what would have been done had their men been elected. However, we have decided, or rather you have decided to make certain men responsible for the work of the year, and you have decided that they shall be responsible as against some other men, and I cannot help but feel that they have been selected to bear a very heavy responsibility. I think we all may congratulate ourselves upon the fact that they are men, all of them, of splendid ability, and men equal to any responsibility which may be put upon them, and that we have a fair outlook for a prosperous year.

I think it is time now that we pass to some other business.

The next business is the discussion of the report presented by Mr. Gartley.

Discussion

of report of committee on methods of taking candle power of gas.

Mr. A. E. Forstall: Mr. President, when I agreed to discuss the report of the committee I had not read the report. Possibly, if I had read it, I would not have undertaken to discuss it. Having read it, I find that they have covered about everything that I intended to say when I agreed to take part in the discussion.

It may be objected that the committee have given us such a counsel of perfection that it is going to be very hard to come up to it, but I think it is well to have the very best possible set before us so that we can come as near to it as we can. If there is any use taking candle-power tests at all, and I think no one will deny that there is value in them, and great

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value, they should be taken accurately, and the committee has shown us how to get ready to take them as accurately as possible.

MR. J. B. KLUMPP: Mr. President, I think that you have had a letter from the Illuminating Engineering Society on this topic, and I think the text of the letter will be as pertinent to the subject as anything I can say. I have a copy of the letter and will read it.

COMMITTEE ON NOMENCLATURE AND STANDARDS
ILLUMINATING ENGINEERING SOCIETY.

Office of the Secretary,
WASHINGTON, D. C., October 16, 1907

WALTON CLARK, *President,*
American Gas Institute.

Dear Sir:

About one year ago, The Illuminating Engineering Society created a committee representing the varied interests in this country and abroad to consider the question of establishing suitable, and if possible, universal nomenclature and standards for the science of Illuminating Engineering.

The question of a common national and international unit of candle-power was taken into consideration by the American members of this International Committee, and upon motion, Dr. A. C. Humphreys, the Chairman of this Committee appointed a sub-committee to confer with similar committees from the American Gas Institute, and the American Institute of Electrical Engineers.

As a result of numerous recent investigations it has been established that the value of the candle unit defined as $^1/_{10}$ of the intensity of the Harcourt ten-candle-power pentane lamp is different from that obtained through the Hefner, by the use of the ratio one Hefner candle = 0.88 British Parlia-

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mentary candle. The amount of the difference is not definitely known, but is probably about four per cent., the unit obtained through the Harcourt ten-candle-power pentane lamp being smaller. Whether this difference is due to a change in the value of either of the two units—the candle unit in England or the Hefner unit in Germany—or whether it is due to errors in the earlier comparisons between the two units which gave the ratio 0.88 is immaterial for our present purpose. The important fact which we desire to present for your consideration is that although in the photometry of both gas and electric lamps in the United States the unit has nominally been the British Parliamentary candle, it has been obtained in different ways in the two industries.

In the photometry of gas the English example has been followed, and the candle unit in use in this country is probably not very different from that in use in England. On the other hand, the unit used in the photometry of electric lamps, following the recommendation of the American Institute of Electrical Engineers, has been obtained through the Hefner by the use of the ratio. One Hefner candle = 0.88 British Parliamentary candle. We are therefore confronted at present with the existence of two different units of candle-power in the United States, differing from each other by about four per cent.

It is evident that such a condition is not only unfortunate, but extremely disadvantageous to the better interests of either industry, and any action that would tend to bring the two units into agreement should be welcomed by all concerned, provided such action does not work hardship upon any of the interests involved.

With the establishment of State Commissions for Gas and Electricity, which will look more and more to the federal Bureau of Standards for standards of candle-power, complications will certainly result if the unit recognized in any industry is not in agreement with that maintained at the Bureau of Standards; and it is obviously impossible for the federal government to maintain and legalize two different units for use in the photometry of gas and electric lamps. In a recent

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paper published by the National Bureau of Standards at Washington, attention was called to this discrepancy between the candle unit obtained through the Harcourt ten-candle-power pentane lamp and that obtained from the Hefner by the use of the ratio 0.88.

In this same paper attention was also directed to the question of possible international action looking toward the establishment of a common unit of candle-power for England, France and the United States. The units in use in these three coutries are so nearly alike that with the accuracy at present attainable in industrial photometry no serious results would follow a compromise by which all three countries would agree upon a common unit of candle-power. If the value of this common unit were taken as the average of the values of the units maintained at the national laboratories in the three countries, it would be very close to the mean between the two units in use in the United States in the photometry of gas and electric lamps. Therefore, a compromise in the interest of international unity would require no greater changes of unit than a compromise in the interest of national unity. Moreover, the change in unit would in no case be greater than about two per cent., and the effect of such a change would not be seriously felt, even in the photometry of incandescent lamps where the highest accuracy in commercial testing is attainable.

Since the German unit of candle-power differs by ten or fifteen per cent. from the average value of the units in England, France and the United States, it would not seem desirable to include the German unit in taking the mean value. Either Germany could elect to adopt the international candle unit, or else the ratio of the Hefner candle to the International candle could be determined.

In consideration of the facts stated above, we, the undersigned, on behalf of the sub-committee of the Committee on Nomenclature and Standards of the Illuminating Engineering Society, respectfully request, therefore, that the American Gas Institute appoint a committee to confer with the sub-committee of the Illuminating Engineering Society on the ques-

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tion of the possible adoption of a common national and international unit of candle-power.

A similar request is being made to the American Institute of Electrical Engineers, and it is hoped through the co-operation of these two representative bodies that some definite action will be taken.

Yours respectfully,

EDW. P. HYDE,
J. B. KLUMPP.

MR. PAUL THOMPSON: In connection, Mr. President, with this letter read by Mr. Klumpp, I will move that the letter be referred to the Technical Committee provided for under the Constitution, for such action as they may deem proper.

Motion seconded.

THE PRESIDENT: I think it would come in much more orderly in the proceedings if these motions should be taken up at the end of the discussion. Will you not hold that motion until later?

MR. THOMPSON: I will withdraw it for the present, Mr. Chairman.

THE PRESIDENT: Mr. Waring, may we have a word from you on this subject?

MR. GEORGE H. WARING: Mr. President, I have nothing to say on this subject which is of any particular moment. I think Mr. Gartley has covered the ground fully. I agree with everything that he has stated, and I would like to emphasize the fact that candle-power is not a power given by one candle, but the average of many. We are liable to have comparisons taken against two candles or more. As Mr. Gartley has very well set out in his paper, it is not the candle-power of one candle, but the average of many.

THE PRESIDENT: Mr. Morehead, may we hear from you?

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MR. JOHN M. MOREHEAD: Mr. Chairman, there is one serious error which is liable to occur in taking the readings of a photometer to which Mr. Gartley did not refer, and one we have found in Chicago to be very real, and that is the error which may arise from differences between the two eyes of the man that is looking at the disc. In looking in the photometer you are looking on one side of the disc with one eye, and on the other side of the disc with the other eye. Now you balance what you see with one eye against what you see with the other without knowing whether the two eyes are the same. Anyone who wears glasses, for anything except age, knows that the formula of an oculist for the lens is never quite the same for both eyes. You take one glass and compare it with the other, and that difference is sometimes quite apparent. If you turn your glasses out and look through them from the wrong side, you will see it makes quite a difference. The old rule on sailing men-of-war was to hold on with one hand and work with the other, or "one hand for yourself and one for the king." Now, if we have one eye for the standard and one for the gas company, and the two eyes are not the same, I think it very well to know which way the good eye is looking. You can get a very close test on that by turning the sight box around and putting a man over on the back side of the bar. Ordinarily a man will be looking at the standard with his left eye, but if you will simply take the sight box and put it on the other way he will be looking at the standard with the right eye. Where there are discrepancies between the reading of two men on the same gas for a long period, you will generally find that there are differences in the eyes of one or the other of the observers.

There is another point by which, it seemed to me, that the committee was putting us in somewhat of a bad light, and that is the wholesale condemnation of the candle as a unit of light. I do not wish to be understood as being a champion of the candles. I know they are bad, and I have a great deal of trouble with them, but I question the advisability of going on record as stating that they are unreliable. Practically all of the or-

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dinances and specifications refer to the "English Standard Candle burning 120 grains sperm per hour" as the standard of light. When the City Inspector comes around to determine the candle-power he will not accept any standard except such a candle. While we know that the Pentane lamp is ten candle-power, we cannot make him believe it. We can say, "there is a ten-candle-power standard lamp," and he says, "yes, I know and there is also a screen on it by the movement of which you can make it nine candles or eleven candles, and how am I to know that it is ten," We reply that "we have checked it with the candles and know that it is ten candles," and he replies that "our determination is the result of one hundred tests which took two weeks and that he must have something to report for the next morning, that his ordinance calls for candles and he would like to compare our gas with a candle." Under the present conditions we say, "your ordinance calls for a standard English candle, burning 120 grains per hour, here is your English candle. Look at it. See the Union Jack on the box, break the seal yourself. There is the candle balance and here is the forty-grain weight. Light them up and see that they are burning at the rate of 120 grains per hour. Now make your determinations and see what you get." Under these conditions the Inspector can make no complaint and he has to report whatever candle-power the test shows up.

If, however, he says, "yes, the gas apparently shows what the ordinance calls for, but a Committee on Photometry appointed from the most experienced and ablest members of the American Gas Institute, says that the candles which I am using as a standard are no good, and that the light is more apt to be something else than it is to be what it appears. Your own Society goes on record as backing up the committee, showing that there are fifty-seven different varieties of objections to the candles and as many sources of error in the determinations which I have just made. For instance, the committee says that the candles will not burn forty grains in ten minutes, that they will not burn uniformly during the ten minutes even when the total consumption is correct, that the candle-power

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of the candle is affected by the vitiation of the atmosphere, by the barometric pressure, by the temperature of the photometer room, by the ventilation of the photometer room, by any atmospheric commotion, that the light varies in intensity, that it varies in color, that it varies with the extent of the water vapor in the atmosphere, and that the committee is not prepared to give any definite formula for correction for the variation for the amount of water vapor when the proportion is known." In one table the committee says that the candles of three samples varied from .930 to .899. According to some figures of the value of the standard given by the committee, an apparently twenty-four candle gas may be either 25.86 or it may be 21, according to the value of the standard. Further, that there is no official manufacturer of candles in the United States, that the industry is sixty years old and we have not a National standard and that there is no way of reproducing the standard. On page 501 the committee says "that out of 118 tests using the standard candle, 80 per cent. of them were 1 per cent. off and out of this average 5 per cent. of the candles were 19 per cent. off."

It often happens that the Inspector is anxious to find a low candle-power and to make trouble for the gas company. When such is the case what argument have we when the Inspector proposes to correct the candle-power which he found to compensate for some of the objections which the committee set forth to the standard by which he found the candle-power. He can say "it looks like a twenty-four candle gas, but the standard may be so much off, that it is only nineteen candles" and quote the action of this Association as his authority for making the reduction.

The candle as a standard is bad. We admit it and regret it, but as a matter of fact it is the only standard which we have and we have got to use it. Even if we were allowed to substitute something else we have no other standard which we could substitute, and as long as we have got to use it, and to stand behind it and to say that it is right, I question the advisability of advertising all of the objections which are set forth in the very able report of the committee.

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MR. CHARLES O. BOND: In reference to the remarks of the last speaker, I feel that I am an advocate of the pentane lamp. I think it is something better than the candles, and it seems to me that if the gas fraternity on the floor of their Institute cannot look for something better, I do not know that we can expect those who are supervising gas companies and commissions to find it for us. I think it is for us to find something better. The pentane lamp is certainly an improvement upon, and has shown a much better record than the candle as a standard. I have come into possession since I came to the meeting of a record of candle determinations kept for a series of eight years. Fortunately, one member present has preserved his readings for this length of time, and gives in detail all the different readings. He has marked down in each case the quantity of sperm consumed in six hundred seconds. That varies from 45 grains down to 34 grains. Now there seemed to be no rhyme nor reason in any method suggested by which we could explain these variations until it occurred to me that we tabulate them on the basis of the probable humidity in the air during the different seasons of the year. We immediately compiled the data for these eight years according to the months. We know where the period of maximum humidity is, and the period of minimum humidity in the course of the year, and by placing the data in that way we found that the average looks much better than it would in the individual cases. In months where there was a small humidity, as in December, there was 40.05. In January, 40.08. February, 40.07. In March, 40.42. In April, 40.35. In May, 40.42. When we come to the months where there was a high humidity, as in July or August, the consumption drops to 38.77 and 38.62, so that this rule bears out what is shown in the report of the committee.

In the report there was a suggestion made relative to some sort of a psychrometer to take the measurement of the humidity in the air. I would suggest that that may also give a very good measure of the vitiation in a room. If this psychrometer is operated outside, and you find the difference between your wet and dry bulb, and you do the same within your room, you will find the increase in the humidity. Now the increase in humid-

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ity and the increase in CO_2 run parallel. Therefore, one is just as much a measure of the vitiation as the other. This will tend to show whether the photometer room is in proper condition for taking the candle-power at any time, and it makes a comparatively cheap method of determining it. It seems to me that the Institute,—I do not know by just what means it will be done,—but it seems to me that there ought to be action taken toward the adoption of a proper burner by which the gas is to be tested. The work ought to be undertaken in some way, and it ought to have the official sanction of this body to go with the decision. If San Francisco should take its candle-power from a flat-flame burner, and Boston, Baltimore, or New Orleans take theirs through the Argand burner, the results are not comparable by any means. I think this matter ought to be brought up.

MR. W. E. MCKAY: Mr. President, I would like to ask a question, and that is with reference to the use of acetylene gas in this connection. I believe that pure acetylene can be used to good advantage. It is possible to store acetylene by compression so that a very small cylinder of acetylene would serve as a standard for taking the candle-power for a company probably for several years. Why isn't it a good proposition to install the acetylene burner and use acetylene as a standard of candle-power? There may be some objections to that, but I do not know what they would be. I simply ask for information.

MR. BOND: Mr. President, there is one question that I would like to ask Mr. Morehead. At what distance was the man from the disc at the time that he took the observation with one eye looking at one side, and the other eye looking at the other side?

THE PRESIDENT: Mr. McKay has asked for information as to what objection there is to the use of acetylene as a standard of candle-power. I would like to hear if anyone can answer that question.

MR. HENRY L. DOHERTY: Mr. President, perhaps I can give a little information on that point. Several years ago I was

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rather interested in acetylene gas. At that time the variety of results secured on the photometer and otherwise rather led me to believe that we wanted a more reliable standard, and acetylene came to notice at that time, but there was always some free hydrogen present, and if we do not get pure acetylene gas, and there is free hydrogen present, we are not going to have a constant quality, and it would cause error in the photometrical readings. Another objection that I see to acetylene gas for photometric uses,—I think it has been considered before, and I think there will be some literature found on the subject,—but it was taken up seriously by the photometrical committee of one of the associations, and it was found objectionable from the fact that it was a difficult gas to burn; more apt to be affected by the humidity of the atmosphere than ordinary gas is, and that if you operate a burner to the best efficiency in dry air a slight change in humidity will change the efficiency of the acetylene more quickly than it will gas that does not require so much air for combustion.

MR. J. B. KLUMPP: I think the adoption of an acetylene burner as a standard would be a rather difficult problem. The burning of acetylene requires a burner that gives a more or less intimate mixture of air, which would be difficult to control and which would greatly vary the intensity of the light given.

If, for instance, an addition of oxygen is made to acetylene it will greatly increase the candles per foot, owing to an increase in the flame temperature, and produce a light too intense for direct comparison with illuminating gas.

Owing to this inconvenience in regulation to burn acetylene with a constant value, I think it would be more difficult to use as a standard than illuminating gas itself.

MR. W. CULLEN MORRIS: Mr. President, on the subject of which Mr. Morehead has just spoken, I should like to add that for five or six years we made a particular study of the inability of the usual assistant around a gas plant to read the bar of the photometer correctly from one side. We have found repeatedly variations running up to as high as ten per cent. where

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a man was using two eyes, and the result of it was that we have issued instructions that if a man has to use two eyes that he must read from both sides of the bar. We have arranged all of our tables in that way, so that the sight box on the bar can be revolved, and we have found in looking over our records that the variation is almost on an average of over five per cent. for the six or seven men that are reading at that particular plant.

MR. MORRIS: Mr. President, I realized after I sat down that I had not completed my remarks. After we had read on both sides of the bar we came to the conclusion that the average of the six or seven men which we have employed in this work was less than one-half of one per cent. apart.

THE PRESIDENT: Dr. Hyde, of the National Bureau of Standards, is here. Dr. Hyde, do you care to speak on this subject?

DR. HYDE: Mr. President and Gentlemen: I appreciate very much the courtesy which you have extended to me to speak to you on the report of your committee on the method of taking candle-power readings of gas. As the President has just explained, I am from the Bureau of Standards, or, as Commissioner MacFarland would say, from *your* Bureau of Standards. We of the Bureau are very deeply interested in all matters that pertain to standards for accurate measurements, and I want to say that I am very glad indeed of an opportunity to express my appreciation of the magnificent work which your committee has done in attempting to unify methods of gas photometry. We are living in an age when systematization is of the most fundamental importance. The time is past when a manufacturer can go off into one little corner of the earth and read his candle-power in any way he wants. It would be unfortunate if a man in Milwaukee and a man in Boston were talking in terms of an entirely different thing. We want system and we want uniformity, and there is nothing that will bring them about so quickly as just such work as your committee has already done, and which I sincerely hope they will continue to do.

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I think it is rather striking that in the progress of the great movement towards systematization, particularly in regard to standards, that photometry should be so far behind the other sciences. We have only one meter bar, and we have only one standard kilogram. Our electrical units are very closely defined throughout the world, but in the measurement of light, the condition is entirely different. There is one unit in Germany, one in England, one in France, and, unfortunately, there are at least two in the United States. It is very desirable that there should be only one unit used in the photometry of gas, and it seems to me equally desirable and almost necessary that the unit that is used in the photometry of gas should be the same as that used in the photometry of electric lamps, as otherwise complications will necessarily result. The Bureau of Standards, I always like to think, should take the place of the dictionary,—it records existing conditions. It should not try to inject new standards or new units any more than it is the office of the dictionary to put new words into the vocabulary. But as you can readily see, if there is no unanimity in regard to units, it is impossible for the Bureau to have a unit which shall be in *general* agreement with the unit used throughout the country. The first step, then, consists in determining upon a common national unit of candle-power.

Even if we have a common national unit of candle-power however, we still have taken only a single step in the right direction. We ought to have a common international unit. I sincerely hope that the day will soon come when we will have but one unit of candle-power, and if we say ten candles or twenty candles, we will mean the same thing whether we are talking of gas or electric light, and whether we are talking in England, France or the United States. The fact of the difference between the units in use in gas and electricity, and the difficulties which have resulted have been known for some time, but the matter has come to a head now. The Illuminating Engineering Society, which perhaps better than any other body in this country represents the various lighting interests, has taken hold of this question through its international Committee on Nomenclature and Standards, of which your honored member,

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the newly elected President of this Institute, is the chairman. The action which that committee has taken in regard to this question is shown by the letter which has been presented to the convention this afternoon by Mr. Klumpp. I certainly hope that you will consider very seriously the communication from the Illuminating Engineering Society. The Gas Institute is the authoritative body of this country in relation to gas matters, and if the Gas Institute will give proper encouragement to this movement it probably will not merely be national but will become truly international in scope.

The fortunate thing about our units of candle-power is that although we have an unfortunate difference, the difference is not very great, and could be done away with readily by compromise without any serious results to either the gas or electric industry. But as our methods of photometry are becoming more accurate every day through such action as your committee has taken in unifying and standardizing methods, and as there is just as much possibility that the units may drift apart as that they may come together, a compromise would in all probability be much more difficult of accomplishment ten years hence than now. How the two candles in use in this country, both of which purport to be English Parliamentary candles, came to be different is a matter which time would not permit me to enter into, and into which I should hesitate to enter even though I had the time. The fact is, that there are two units, and the further fact is that they are not so very different at present,—about four per cent. or so. If the gas industry is willing to come up about two per cent. in their candle, and the electrical industry is willing to drop about two per cent. in theirs, we will meet on a common ground.

One other very fortunate element connected with this situation is that the intermediate value between the two units in use in this country is very close to the average value of the unit candles used in England, France, and the United States. Hence, as was stated in the formal request from the Illuminating Engineering Society, any compromise in the interest of national unity would, at the same time, be a compromise in the interest of international unity, and the time, probably, would

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soon come, if the movement had the unqualified support of such bodies as this, and of the American Institute of Electrical Engineers, that we should have not only a common unit in the United States, but a common unit throughout the greater part, at least, of the civilized world.

There is one other matter which Mr. Gartley asked me to speak to you about before I close, and which is entirely different from that on which I have just been speaking. I refer to visiting the Bureau of Standards. If there are any here who while they are in Washington have the opportunity, I should like them to visit the Bureau of Standards, and see the work that we are doing, and the equipment that we have. I would like to extend to you, on behalf of the Bureau, a very hearty invitation to come out. We would be very glad to have you come together at some one time, or to come separately, if that is more convenient. You will find some one out there who will show you the photometric apparatus, together with any other work which you may be interested in. It will help you to see how we can help you and it will help us to learn from you how best we can help you. I hope that as many of you as possible will avail yourselves of this invitation and come out and see what we are doing.

MR. H. L. DOHERTY: Mr. President, there is one point that I would like to call the attention of the convention to as it may shed some light on the value of this subject from the gas man's standpoint. I do not want to discount the advantage of knowing all about candle-power, and how to properly measure it, but I often think that the gas man overestimates the importance of candle-power. About two years ago when it was proposed to fix the candle-power for a certain western city the engineers and the men interested were asked to say how much of the gas was burned in open tips. They made various guesses, and then they were asked to sit down and figure it out accurately. It was estimated by some that twelve per cent. of the gas was burned in open tips, and others estimated it as low as four. It was then decided to take from similar cities where different rates prevailed for fuel and light, as that would

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give a better indication of how much was used for illuminating, and then estimating how much of that gas was used in open tips. The determination was not far from six per cent. In other words, that only six per cent. of the gas was interested directly in candle-power, and that ninety-four per cent. depended on the quantity of heat and flame temperature, a ratio that I know would not apply throughout cities where they have a high candle-power. In a great many cities of the country where they have fuel gas development, not over from six to ten per cent. of the gas depends for its value on its candle-power value.

THE PRESIDENT: Are there any further remarks on this paper? Mr. Gartley, do you care to say anything further?

MR. WILLIAM H. GARTLEY: Mr. President, it has been suggested that we supplement the paper with directions for making photometric readings. In Appendix C we do give a method for standardizing and another method for taking the readings. Of course, we do not go so far as to touch upon each variety of standard, but we give an illustration of how it should be done.

Mr. Morehead has made some keen observations, and he referred to this as "Mr. Gartley's paper." I want to tell him it is more dignified than that, that it is the report of the committee and not my paper.

Mr. Morris has also referred to the source of error that comes in through the difference in the eyes in the power of observation or definition. The committee has covered that point on page 462, in which they refer to the substitution method, and that is worthy, I think, of a little consideration.

"The committee is of the opinion that while advocating the continued use of the bar photometer, yet every means contributing to its greater accuracy should be encouraged. To this end we recommend the 'substitution' method in testing gas. It is known that in most cases if two lamps, A and B, prove equal when A is at the left of the bar and B is at the right, yet they may differ slightly when B is at the left and A is at the right. This may be due to personal equation, to air drafts, unequal

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reflecting surfaces, or other contributing causes. If, however, A is known to have a standard value, and the desire is to test the candle-power of the gas against A's units, then substitute A in the place that will be used by the gas and evaluate B in A's terms in the position which B will continue to occupy. All that is now desired of B is that it shall continue constant, yielding always the value given it by A's units. A is then taken away, and the gas is swung into the position which A occupied. It is here subject to exactly the same environment that A had, and, through comparisons with B obtains its candle-power in terms of A. Furthermore, A, being the standard of reference, is used least and will be preserved longer." Furthermore, personally, I do not believe that there is very much difference to be found in photometrical work due to the difference of the two eyes, although I think that the suggestion that Mr. Morris makes of having a bar with a graduate on both sides, and a reversible disc is a very excellent and practical means, and more likely to be of value in proving, to my mind at least, and to the mind of a great many of the United Gas Improvement Company photometerists that there is not very much difference to be obtained due to the difference in the power of the eyes. The sight box should be and generally is so constructed that both eyes are used on each side of the disc. I think, however, Dr. Hyde will agree with me that this "substitution method" is a well known scientific method of overcoming that difficulty.

DR. HYDE: I think it is considered a better way comparable with the other methods of taking the readings. It eliminates not only the possibility of error from difference in the eyes, but it eliminates all dissymmetry in the photometer, and some difference which would come in on the two sides. We use that method entirely at the Bureau.

MR. GARTLEY: Mr. Morehead objects seriously to any disparagement of the candle by this Institute. I think we have all recognized for a number of years that that is the sticking point in the subject of photometry, and yet, while the report of the committee has made an attack, so to speak, or, not made

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an attack, but have stated some of the facts regarding the candle, Mr. Morehead has not stated that any of those facts or those statements are incorrect. He regrets that they are made. We recognize, and it is so stated in the report, that the candle does most of the work of standardizing in photometry, especially in this country. In a great many instances franchises, ordinances of councils, and state laws require that the standard candle shall be the standard by which or against which the value of the gas is judged in determining its illuminating value, and we have tried to show that the matter is not without a definite solution; that we can still get along and make progress in photometry if we will once take the stand that the candle, an individual candle, is not a reliable standard. Now the inspectors of gas from municipalities and the states may argue and say that that is what it says, and you must compare it with that, but neither the gas company nor the inspector gets the whole truth on the subject. Until very recently the matter was really in bad shape, but we now have presented to us a means of determining the unit of light. We have a means of preserving also what is meant by one candle-power. Admitting that one candle-power is the average of a very large number of candles, we can determine what that unit is, we can decide on it, and we can preserve it. The electric glow lamp operated under proper conditions will run for three or four hundred hours, I think, without change of more than one-half of one per cent. It can be turned out and re-lighted, if you call that re-lighting, without any impairment, provided you do not let the voltage go above a maximum limit. Consequently, we can determine the unit and put it in the hands of the Bureau of Standards, which is a national affair and unprejudiced from one side or the other. These electric incandescent lamps having a value in terms of the unit, can be sent out to the different laboratories of the country, they can be sent out to the gas companies wherever they have electric power and a storage battery. You can then take your standard flame lamp and you can compare that standard lamp against this electric lamp, this custodian of the unit singly or in multiple under normal atmospheric conditions. If the committees of the various societies,

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interested agree on what the unit is to be, the Bureau of Standards can always supply it, and there can be no objection on the part of any rational authority of a municipality or state to the extent that they will not use it or that they will not accept that as a standard candle-power.

I wanted to call attention to that table photometer. It is a photometer that has been devised by the Gas Referees of London, and is used exclusively by them in their determination of the candle-power of London gas. I would like to ask if any gentleman has a photometer like that in this country. (No reply.)

MR. J. B. KLUMPP: Mr. President, I do not know whether this subject has been closed by what Mr. Gartley has just said or not, but I would like to take just a moment. The point I should like to bring out is the difficulty of making a comparison of an electric vacuum standard with an open flame standard, or vice versa. These comparisons can only be made under certain atmospheric conditions and I think that gas men should appreciate this. It would be practically impossible for the average gas company to use an electric standard to determine the candle-power of its gas.

True comparison could only be made under certain normal conditions of humidity and vitiation, and it would be next to impossible to obtain these normal conditions the greater part of the year. For instance, during July and August, when the air is heavily laden with moisture it would be necessary to reduce this excessive quantity of water vapor by artificially drying the air, or by the introduction of some correcting factor obtained by careful experiment. Conversely would the effect of the excessively dry state of the atmosphere during the months of January and February need correction.

The work of comparing a vacuum electric lamp against an open flame can only be correctly done by experienced observers, and then only with the use of exact instruments and good laboratory equipment to carefully observe and record the conditions of the atmosphere, and owing to this difficulty I think I am safe in saying that there is not one gas company in one

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hundred that has the equipment to attempt to make such comparisons with definite results.

MR. ROLLIN NORRIS: Mr. President, there is one point in this connection upon which I would like to say a word. It is sometimes assumed that, because a franchise or ordinance specifies that the gas sent out under that franchise or ordinance must be of a quality that will give a light equal to so many standard sperm candles, the test must be made against actual candles. I think this position is in error, and that the test can be made against any reliable secondary standard whose value may be expressed in terms of the ordinary candle. I think it is important to bear this in mind because it is a mistake often made.

MR. A. S. MILLER: I think, Mr. President, that this matter is one of very great importance. The good work ought to go on, and I move that this committee be discharged with the thanks of the Association, and that the work be referred to the Technical Committee, with the request that it be continued.

MR. GEORGE H. WARING: Second the motion.

THE PRESIDENT: Mr. Forstall made a somewhat similar motion which, I think, is pending.

MR. FORSTALL: I will withdraw mine, Mr. President, with the permission of my second, if it was seconded.

THE PRESIDENT: Very well, gentlemen, you have heard Mr. Miller's motion. Any remarks? All in favor of this say "Aye." Contrary minds "No." Carried.

The next business in order is the report of the Public Policy Committee. Is Mr. Gardiner ready to report?

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REPORT OF THE COMMITTEE ON PUBLIC POLICY OF THE AMERICAN GAS INSTITUTE.

This Committee is new to the American Gas Institute, and therefore it conceives that in this its first report, it should state what it believes to be the intent of its appointment, and the scope of the work with which it is entrusted.

The gas business, of which the American Gas Institute is the national representative, embraces matters and relations of a physical, engineering and financial nature, and relations to and with its patrons, the public, and the official representatives of the latter.

We believe that the intent in appointing this committee was to establish an organization within the Institute, which should consecutively, progressively and constructively study, suggest and report upon any subject touching the relations of Gas Companies to their customers, their employees, the public and its officials, in brief all matters of Public Policy, or relations as distinguished from engineering matters, and matters internal to the operation of a Gas Company.

In this connection we would note that the other Associations in the public service, the American Street & Interurban Railway Association, and the National Electric Light Association, have similar standing committees, and we are happy to report at this time that permanent relations have been established with these other committees for mutual co-operation in the study and evolution of our relations to the public.

In this era of social unrest, it is evident that conditions and relations, which in the past may have been satisfactory, are perhaps no longer so.

Your committee conforming with the action of the other committees above mentioned, has attempted, first, to ascertain those items of our relations to the public most in evidence, and second, to study suggestions and means for their improvement, but we have not deemed the time ripe as yet, or our studies to have progressed sufficiently to warrant more advanced action.

To facilitate this student work the committee first elected Mr. W. H. Gardiner of New York, its Secretary, and was

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then organized by appointments by its Chairman into the following sub-committees:

Public Regulations and Control, Mr. F. W. Little, Chairman, and Mr. A. P. Lathrop;

London Sliding Scale as applied to Gas, Mr. John Williamson, Chairman, and Mr. W. H. Gardiner;

Taxation and Franchises, Mr. Paul Thompson, Chairman, and Mr. F. W. Little;

Industrial Insurance, Rewards and Pensions, Mr. A. P. Lathrop, Chairman, and Mr. Irvin Butterworth;

Publicity and Popular Education, Mr. Irvin Butterworth, Chairman, and Mr. Paul Thompson.

Appended to this report are the reports of these sub-committees, excepting only that of the sub-committee on Taxation & Franchises which did not make a report. We trust that each one of these reports will receive the careful consideration of our members, as each deals with a problem, the best solution of which would materially contribute to the improvement of our public relations; but at this time we have no recommendations to make beyond the submission of these reports to your attention, and the statement that in the field of work undertaken this year by your committee we find great scope and opportunity for study, improvement and co-operation. We therefore trust that the Institute will continue a committee in this work.

Respectfully submitted,

E. G. COWDERY, *Chairman,*
W. H. GARDINER, *Secretary,*
IRVIN BUTTERWORTH,
A. P. LATHROP,
F. W. LITTLE
PAUL THOMPSON,
JOHN WILLIAMSON,
Committee.

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REPORT OF THE SUB-COMMITTEE ON PUBLIC REGULATION AND CONTROL TO THE PUBLIC POLICY COMMITTEE OF THE AMERICAN GAS INSTITUTE.

The report of the Secretary of the Public Policy Committee shows that many measures have been before the legislatures of the various States during the past winter, having for their object some form of supervision and regulation of Public Service Corporations. Important legislation affecting public utilities has been adopted in New York, Wisconsin and Missouri, and similar action may be expected in other States.

The traditional policy of the Federal Government and of most of the States of the United States has from the beginning been to rely upon individual initiative and open competition, either active or potential, to bring about fair prices for products not only of general merchandise, but for those particular services rendered by public utilities. These competitive conditions even when but potential necessarily require secrecy in accounting since a producer could not justly be required to expose the details of his accounts and practically his entire business to a competitor.

During the eighty and odd years which have elapsed since gas was first introduced into America, this system has worked with a fair degree of satisfaction to both consumer and investor. The rule has been substantially uniform, that each decade has required every gas company to double its investment to adequately respond to the demands of its increasing number of consumers scattered over an ever increasing area. Throughout the greater part of the country, local supplies of capital have been insufficient to meet local demands for improvements and extensions, and these demands have only been met by the inflow of capital from other sections where local demands were less and supplies greater.

Considering the area per unit of population embraced within the corporate limits of most American municipalities, the rapid antiquation of manufacturing and distributing plants, due to increasing growth and the shifting of residential and

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business centers, the insufficiency of local supplies of funds and the frequent swing to and fro of the pendulum of general prosperity, the system which has prevailed may fairly be said to have worked well as applied to the gas business as a whole. Public obligations to furnish sufficient supplies of gas at fair prices have been generally well met while investors have had a fair return for the use of their money.

Now, however, in response to the demand for governmental supervision or regulation of all public utilities, and as an alternative to municipal ownership and operation it is proposed to substitute for the old conditions a system of State supervision and regulation of gas companies through the medium of commissions. Your Sub-Committee believes that this movement is not inherently antagonistic to the best interests of the public and of the owners of gas properties and recommends that it be met in a fair and friendly spirit in an effort to direct it into just, equitable and conservative channels, to the end that initiative, progress and fair dealing be stimulated, and antagonism and unfairness be eliminated.

The public may rightfully demand ample supplies of gas at the lowest possible prices consistent with a fair return upon the value of the property devoted to its use and there seems no natural reason why the interests of the public and the interests of the owners of gas properties should not run together. When the State takes over the supervision and control of private property devoted to a public use, it is in duty bound to afford a full measure of protection to that property as well as like protection to further capital which may be invested in response to the public demand.

If supervisory and regulating commissions are to be constituted, the members should receive their appointments directly from the State, their term of office should be lengthy, and their compensation adequate, to the end that efficient and trustworthy men may afford to hold these positions; and their terms should expire at different times so that at all times a majority of the members may have the benefit of the past experience of the commission and the Commission itself maintain a consistent policy. Members of the Commission should be re-

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movable only for cause and such other safeguards should be thrown around their tenure of office as to make the position non-political on the one hand, and free from improper influences on the other.

Every law creating supervisory commission should contain within itself clearly stated rules by which the acts of the commission should be guided. The powers and responsibilities of the commission should be as clearly defined as the powers and responsibilities of the corporations whose acts it is proposed to regulate and the operation of the law should be as nearly automatic as is possible.

The conclusions of your Sub-Committee are:

A. That the change from the policy of open competition as a regulating force, and secret accounting to State Supervision and regulation with public accounting is not inimical to the interests of the owners of gas properties provided that it is accompanied by protection to the values of the properties supplying the public need. Such protection is as necessary to the public interest as to the corporations, since without it capital cannot be secured to make necessary extensions and improvements.

B. Commissions should be appointed in such a manner and be assured of such a tenure of office as will make them free from political dictation and from the pressure of a local sentiment which might prevent them from dealing justly with the public and private interests before them.

C. Commissions should regulate the granting of all franchises, should adopt and have power to enforce a uniform system of accounting, auditing and reporting and should protect the interests of the users of gas and the companies supplying the same. While securing these results to the public the aim of the Commission should be to encourage in every legitimate way individual enterprise and initiative.

Respectfully submitted,

F. W. LITTLE, *Chairman,*

A. P. LATHROP.

Sub-Committee.

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REPORT OF THE SUB-COMMITTEE ON THE LONDON SLIDING SCALE, AS APPLIED TO GAS, TO THE PUBLIC POLICY COMMITTEE OF THE AMERICAN GAS INSTITUTE.

Some of the present antagonism of the public toward public service corporations, originates in claims of improper or inadequate service, but in the great majority of cases this public antagonism is founded on a popular belief that charges for service are too high. On the other hand, owners and managers of public service enterprises assert that charges are now so low and there is such public unrest that adequate dividends cannot be paid, and the moneys necessary for improvements and extensions cannot be obtained for this reason, and because of the supposed present insecurity of public service enterprises.

The public wants excellent and adequate service at the minimum price possible, while the public service companies want the maximum net earnings and perfect security to their enterprises. In many instances at present neither the public nor the companies believe that they are being properly served or treated in any of these respects, each by the other.

The London Sliding Scale would seem to give promise of eliminating these several opposing interests and their resultant antagonism, and this by linking the self-interests of each party to those of the other so that their ends are mutually and simultaneously satisfied. Higher dividends are promised and assured as an incentive to lower prices and the lowest possible prices are assured since maximum dividends can result only from the minimum possible price. The relation of price to dividend and vice versa is by the Sliding Scale established in a constant inverse ratio, one to the other, which yields not only ever decreasing prices and hence ever increasing allowable dividends, but also it assures both in a constant ratio which endows the situation with an equity and security otherwise unobtainable.

Other methods of public control of gas companies and of regulation of their prices and service, seek to accomplish their ends generally by restrictive or prescriptive ordinances, rulings

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and legislation, or by arbitrary bargains which usually are or become more or less inequitable to one or all parties thereto. These bargains may be dismissed without further consideration merely because they are not of a permanent nature nor in the aggregate are they based on homogeneous and established principles. Restrictive and prescriptive legislation, etc., seeks to obtain its ends—especially in regulating prices—by commanding companies to conform to conditions which will allow of their making and paying but the minimum legal return under the United States Constitution. Obviously a series of such actions will eliminate any direct incentive to make improvements in service and reductions in price. For as no increase in direct profit is tolerated why seek to improve when improvement is profitless?

The London Sliding Scale on the contrary offers a direct and proportional incentive to improvement. It is based on the theorem that self-interest is the greatest stimulus of material progress and efficiency. Instead of seeking improvements for the public by constantly wielding the public "Big Stick" it obtains them by allowing public service companies to pay ever increasing profits but only in direct proportion to the improvements in service and its price that the Company gives to the public.

Although established and in successful operation for many years in England, the Sliding Scale is of recent importation to this country. But happily now we can get data of its workings in this country from the case of the Boston Consolidated Gas Co. which has been operating under this system for some time.

We may perhaps best summarize the results in the Boston Gas situation by quoting in part a public statement issued on June 24th, 1907, by Louis D. Brandeis, Esq. In explanation it should be noted that Mr. Brandeis is considered the dominant personality in the Public Franchise League of Massachusetts, which has been and is very active in legislative matters when it conceives that it can foster or protect the interest of the public. He said in part:

"The reduction in the price of gas just announced by the

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"Boston Consolidated Gas Company, from eighty-five cents to eighty cents per thousand feet, is an event of more than local or passing significance. The reduction follows quickly after three other reductions in the price of gas made by the company within a period of two years, the first on July 1, 1905, from $1 to ninety-five cents; the second on Jan. 1, 1906, to ninety cents; the third on July 1, 1906, to eighty-five cents.

"To have made a reduction in price of twenty per cent during so short a period, in which prices for labor and materials have risen so largely, is certainly a remarkable achievement. It will mean a saving to the people of Boston next year of $800,000 over what gas would have cost them at the old price of $1 if the estimated consumption of four billion feet is reached.

"Fortunately the results to the stockholders of the company have also been eminently satisfactory, and they may hope soon to reap their just share under the law of this remarkable achievement. The common stock of the Massachusetts Gas Company (which owns the Boston Consolidated Gas Company) has been put meanwhile upon a regular dividend basis, and already pays three per cent. per annum. Since April, 1905, the market price of the common stock has risen from 44½ to 57½. To appreciate how great this rise actually is we must bear in mind the heavy depreciation in stocks generally now as compared with 1905. For instance, the stock of its competitor, the Edison Electric Illuminating Company of Boston, which sold in April, 1905, at 255, now sells at 206. American Telephone & Telegraph Company, which sold in April, 1905, at 142, now sells at 104½. New York, New Haven & Hartford stock which sold in April, 1905, at 202 sells now at 160.

"The high price of Massachusetts Gas preferred is quite as significant as the rise in common. This preferred stock, limited to a four per cent. dividend sells to-day at only 1½ points lower than in April, 1905, although the old standard guaranteed stocks, like Boston & Albany and Boston & Lowell, have dropped in price forty-five to forty-eight points as compared with April, 1905. This shows the standing which the Massachusetts Gas has attained as a trust investment."

He goes on to say the following, which we quote merely as

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he, a public character, considers it a fair statement of pre-eminent importance.

"These great economic gains are not, however, the only, or indeed greatest gains to the community, which the last two years has to record in the Boston Gas Management.

"[Boston] Gas properties which for the greater part of twenty years have been the subject of financial and political scandal and corruption, exciting the bitterest hostility on the part of the people, have been conducted in a manner so honorable as to deserve and to secure the highest commendation on all hands. The officers and employees of the company, instead of engaging in lobbying and other political activities, have devoted themselves strictly to the business of making and distributing gas, and with such ability and good effect as to attain in an almost incredibly short time for the people, cheap gas; and for the investors, security and the prospect of large returns.

"These remarkable gains are the direct result of the wise, progressive and efficient management of President Richards and his associates, operating under the wise and progressive legislation promoted by the Public Franchise League."

As to the specific methods whereby the results first stated by Mr. Brandeis are obtained, we might summarize the Boston Gas Sliding Scale by saying that a special act of legislature established the standard dividend of the company as 7 per cent. of the par value of its capital stock and the initial price as ninety cents per thousand cubic feet, further providing that reductions of 1 cent per thousand each entitled the company to subsequently increase its rate of dividend by one-fifth of one per cent. In other words dropping the price from 90 cents to 80 cents allows of the dividends being raised from 7 per cent to 9 per cent. and so on proportionately for subsequent and further reductions.

It will be noted that in the Boston Gas Sliding Scale above outlined, a definite increase in the rate of dividend on the capital is the incentive offered for and made proportional to stated reductions of the maximum of gas. This is a direct copy of the plan used for many years in London and would seem to be open to several objections. First, it bases the relation of divi-

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dends to reductions in price on what cannot fail to eventually be an arbitrary and more or less inequitable ratio. Speaking of this ratio in London the Majority report of the Massachusetts Special State Committee on the Sliding Scale, which visited England to study this question, says on Page 27:

"The reasons for the ratio 1d. and one quarter of one per cent have left no trace in history, and such inquiry as we have been able to make among those prominently identified with the question at the time, fails to disclose the reason for settling upon these precise figures."

In the Boston case the ratio at the outset was not entirely arbitrary, as the annual sales were about three billion cubic feet and the capital stock had a total per value of about fifteen million dollars. Therefore as a reduction of five cents saved the public $150,000 and as it entitled the company to pay 1 per cent ($150,000) additional dividends, the principle of equal division or share and share alike between the public and the company was established at the outset. But, unfortunately, it was thus permanently established for the reason that obviously the ratio of fifteen million dollars of capital to three billion cubic feet of sales will not, and in fact has not, been maintained.

On the one hand it might have been and may ever become necessary to increase the capital stock. This under the law entitles the company to a larger *amount* of premium dividends for every cent of reduction in price regardless of the volume of sales and of the amount of saving to the public.

On the other hand, an increase in consumption in excess of its initial relation to the capital stock does not yield to the company its proportion to the amount of saving the company effects for the public.

It would seem to be superfluous to discuss the details of this and other shortcomings of the Boston Gas Sliding Scale, as this has been done in a paper entitled "The London Sliding Scale as a Method for the Government Regulation of Public Service Corporations," presented before the National Electric Light Association in June, 1906, and obtainable from that Association. Appended to this paper is an exhaustive report on the Sliding Scale in England and a large English bibliography

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on the subject. Suffice it to say here, that the proposition discussed in this paper is in effect that a permanently equitable Sliding Scale should not be based on an arbitrary ratio of the rate of dividend on an arbitrary and changing capitalization, to merely the maximum price per thousand feet. The new plan therein suggested is, that after establishing standard conditions, a fair price which shall yield a fair return upon the fair value of the company as a going concern, the increment dividends allowed as rewards and incentives to price reduction shall be merely *equal in amount* to the savings effected for the public by reducing the price. This ratio or relation is obtained by making them equal in amount to the reductions in the average price, (below the initial average price) multiplied by the contemporaneous volume of sales.

While this new system may or may not effect the results claimed by introducing the volume of service into the equation, it is notable in its substitution of the average price for the maximum price. In the present unsettled condition of the rate question, the maximum may evidently become of but very minor import, while the average price of sales to the public is ever the closest index to any public situation as a whole.

In conclusion your Committee would quote the following paragraphs from the Report of a similar sub-committee of the Public Policy Committee of the National Electric Light Association for 1907. Their report is pertinent and the following quotations we consider as applicable to gas as to electricity. They say:

"Your committee is not prepared to recommend definitely any particular scheme or method for the application of the theory of the Sliding Scale as applied to the supply of electricity. It feels that such a recommendation should be postponed until after the matter has had full consideration and discussion. Your committee is, however, prepared to urge the very serious consideration of the application of this attractive theory to the business of the various companies in interest as soon as a safe and satisfactory working basis for it can be established. Its advantages to the companies, to their customers and to the public are altogether too great to be lost if it is practicable to secure them."

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"Your committee submits the foregoing suggestions in the hope that the subject may be further pursued, not only by a committee of this association, but by the individual companies in interest, so that at the next convention of the association decided progress may be reported and more definite conclusions formulated."

Respectfully submitted,

JOHN WILLIAMSON, *Chairman,*
W. H. GARDINER.
Sub-Committee.

REPORT OF THE SUB-COMMITTEE ON INDUSTRIAL INSURANCE, REWARDS AND PENSIONS TO THE PUBLIC POLICY COMMITTEE OF THE AMERICAN GAS INSTITUTE.

The committee on Industrial Insurance, Rewards and Pensions is pleased to submit the following report of the various methods in operation, both in this country and abroad, in connection with the above mentioned subject.

Our report is to a great extent a copy of a recent report made by a similar committee of the National Electric Light Association, and we wish to express our thanks to the officers of that association for the privilege they have granted us of using it. (For this report see page 561.)

In addition to the report of the Electric Association we submit complete copies of plans followed out by the Milwaukee Gas Light Company and the New Haven Gas Light Company referred to therein, and in addition present methods adopted by the Grand Rapids Gas Light Company, the Columbus Railway and Light Company and the United States Steel Corporation. There are many excellent plans followed out by the different organizations, and we hope that from some of them the Institute will be able to evolve a plan which it can recommend for general adoption.

ALANSON P. LATHROP, *Chairman,*
IRVIN BUTTERWORTH.
Sub-Committee.

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REPORT OF THE SUB-COMMITTEE ON PUBLICITY AND POPULAR EDUCATION TO THE PUBLIC POLICY COMMITTEE OF THE AMERICAN GAS INSTITUTE.

Your committee on the subject of "Publicity and Popular Education" have given it much consideration and have sought the views thereon of a number of leading gas managers.

There are three directions in which it is to the interest of gas companies that their respective communities be specially educated:

(1) In the knowledge of the existence, use and economy of the numerous gas appliances for lighting, heating and industrial purposes.

(2) In a broader, fairer and more friendly feeling toward gas companies; and,

(3) In the doctrine that proper public regulation and control of gas companies is better than municipal ownership.

In promoting the first of the above-mentioned objects, each manager can readily choose and apply any one or more of the numerous well-known publicity and educational methods now in vogue, such as newspaper advertising, pamphlets, circulars, follow-up letters, lectures, solicitors, new business departments, etc.

In bettering the present feeling toward gas companies, which, however, is not so hostile as many of us probably imagine, a most effective course is for each individual manager to keep his own "door-yard" scrupulously clean, by means of reasonable rates and good service, and then see that his local newspapers receive authentic information for giving publicity to such gas matters as may be of legitimate interest to their readers.

While now there seems to be but little tendency toward the municipal ownership of gas works in this country, the popular inculcation, by the gas companies themselves, of the doctrine that public control is better than public ownership is rather more difficult, for the reason that, being an interested party, their arguments are usually discounted. Undoubtedly

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the newspapers furnish the best and practically the only effective means of popular education in this matter. If each local manager should so conduct the business of his company that he could "come into court with clean hands," it should be possible, if not comparatively easy, for him to secure, by perfectly frank and open means, the publication, on their merits, in his local newspapers, from time to time, of such items, facts and arguments, selected from the mass that is now readily available to us all, as may serve to prevent his community from coming out on the wrong side of this question. In this connection we commend to the perusal of all gas managers the article entitled "Tainted Publicity," in *Progressive Age*, of August 1, 1907.

Respectfully submitted,

IRVIN BUTTERWORTH, *Chairman.*
PAUL THOMPSON.
Sub-Committee.

NATIONAL ELECTRIC LIGHT ASSOCIATION. REPORT OF SUB-COMMITTEE ON INDUSTRIAL INSURANCE, REWARDS AND PENSIONS, MAY, 1907.

To the Committee on Public Policy, National Electric Light Association:

Gentlemen—Your Committee on Industrial Insurance, Rewards and Pensions begs leave to submit the following report of the investigations which it has made during the past year of the methods adopted in this country in connection with beneficial associations, pensions and profit-sharing. It has also in its investigations considered the plan that has been in operation for a number of years in the South Metropolitan Gas Company of London.

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Except in a few instances there have been no profit-sharing plans adopted by the utility corporations of this country, and in those instances the profit-sharing has been calculated as a dividend upon the wages of the employees. We find, however, that it is becoming quite prevalent to inaugurate beneficial associations in connection with the operation of utility companies upon plans generally laid down on lines similar to those adopted by the large railway companies of the country.

Your committee gives to some extent in detail the plan of the Pennsylvania Railroad Company, which is representative of the plans used by the other large railway companies throughout the country.

References are also made to the plan that has been in force in Philadelphia for many years, which has been broadened out in the manner given in detail in the report; also the plan in operation in Providence, R. I., the figures of which to date are attached, as well as the figures in detail of the operations for a series of years of a beneficiary association organized under the auspices of the employees of a public-utility company in one of the large cities of the country; also to the pension order issued by the Boston Elevated Railway Company in 1903; and the profit-sharing plan adopted by the New Haven (Conn.) Gas Light Company and the Milwaukee (Wis.) Gas Light Company.

The purpose of your committee has been to gather together as much information as possible regarding such associations and such systems of insurance, rewards and pensions as have been adopted throughout the country. While your committee is aware of the fact that many of the companies connected with the association are operating under conditions that make it impossible for them to have any special organized system to accomplish this purpose, at the same time it feels that wherever it is possible to adopt such plans, or similar plans to those which have been described in this report, it is well to do so; and would further suggest to those companies that cannot at this time, for different reasons, adopt such systems, that they operate as far as possible upon the general principle of doing what-

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ever is possible to promote the health, happiness and comfort of the employees of their respective organizations.

It might be possible, in the case of the smaller companies, that operatives who have been with these companies for a great many years, who have been faithful and have always worked for the best interests of the company, could be rewarded by a small percentage of increase in pay, commensurate with such services and proportionate to their term of service. As many such operatives have nothing to look forward to for the future in the way of advancement of position, a plan of this kind would give them some inducement to remain with the company and an increasingly bright outlook from year to year. If it is possible, where men have been for a long term of years in service, to place them in positions where their labors can be lightened, such men should be recognized; and if, from old age, they are finally forced to resign, if it is possible and consistent with the demands upon the various companies to pension them at half pay, or at any rate which would give them some consideration, it should be done. The tendency with all such plans is to lighten the burden of the employee, increase his efficiency by reason of the peace of mind that comes from such a condition, and safeguard the interests of the company by encouraging closer, deeper and more harmonious relations between the employee and the company that employs him.

Respectfully submitted,

JOSEPH B. MCCALL, *Chairman*,
J. W. LIEB, JR.
Sub-Committee.

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APPENDIX TO REPORT OF SUB-COMMITTEE ON INDUSTRIAL INSURANCE, REWARDS AND PENSIONS.

[N. E. L. A.]

PROFIT-SHARING

The profit-sharing plan of the South Metropolitan Gas Company of London—copy of which, with various details, we received through the courtesy of our secretary, Mr. Gardiner—can be briefly stated as follows:

The officers and employees of the company who sign the agreement of employment (copy of which is hereto attached) participate in the profits in the form of a percentage upon their salaries, rising and falling with the price of gas and the stockholders' dividends. The initial rate, when the plan became operative in 1889, was one per cent. upon their salaries, based upon gas at practically 50 cents per thousand cubic feet. Inasmuch as the London sliding scale, authorized by act of Parliament, entitled the stockholders to an increase in dividends as the price of gas to the consumers was reduced, the plan provided for a proportionate increase in the employees' participation; and inversely, as the price of gas increased, the dividends and the participation decreased. In fact, the principle of the London sliding scale is the basis of calculation of the profit-sharing plan.

At first the percentage of profits to which every employee was entitled on this basis was paid to him as a cash bonus, with the privilege of permitting the employee to leave his fund on deposit with the company, at an annual rate of interest.

Sir George Livesey, who was the author of the London sliding scale and also of the profit-sharing scheme that was adopted, states in his paper upon the subject that a great proportion of the employees from the beginning availed themselves of the opportunity of leaving the fund on deposit; while others invested in building stock, and others used it to purchase the company's stock; but about one-half of the number, it was discovered, withdrew their bonus as soon as it was paid and therefore derived no permanent benefit from the system. These

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conditions led to a consideration by the company of some method by which the profit coming to the employees would be invested in such a way as to make a permanent connection between the employee and the company, with the result that in 1894—after nearly five years of trial—a new schedule of rates was made, providing that one-half of the bonus under the schedule to which employees were entitled should be invested by three trustees in the company's ordinary stock, which was then paying five per cent. interest, until the amount credited to the employee was sufficient to give him a stock certificate in his own name; the remaining half in all other respects subject to the same conditions as the old schedule; in other words, subject to withdrawal upon notice, or to be left on deposit at four per cent. interest. The interest rate on deposits has been changed with the appreciation of the market value of the stock.

As the natural outcome of the purchase of the company's stock by the employees, the question of representation in the board of directors of the company arose. This happened after the investment of about £20,000 of the fund. There does not appear to have been any reason for this, excepting the broad and general one of educating the workmen to a better understanding of the commercial side of the business, as their holdings in comparison with the total worth of the company—about £5,000,000—were not entitled to any such consideration. In 1898, when the fund reached £40,000, two workmen directors were elected, it being necessary to secure an act of Parliament to enable this to be done.

While the wisdom of such a policy may be questioned, it is a fact, according to Sir George Livesey's statements, that it has been eminently successful in this case.

These workmen directors are voted for by the workmen only—the qualifications being continuous service for not less than seven years, and the holding for 12 months prior to the election of not less than £100 of the stock of the company and continuing to hold the same. The method of voting is prescribed in the agreement, and permits one vote for every £10 of stock held in the name of any employee, or jointly with his wife and children up to £100; one vote for every £25 above the first £100

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up to £300; one vote for every £50 above the first £300 up to £1,000. Above £1,000, no more votes; thus giving a maximum of 32 votes for each £1,000 holding; the object in this, as declared by Sir George Livesey, being to permit the choice to remain largely with the more thrifty and stable of the workmen. The directors are elected by the year, one retiring each year.

The purpose of this plan of the South Metropolitan Gas Company has been eminently successful, as there are to-day about £200,000 of the employees' money invested in the shares of the company, representing nearly three-fourths of the total bonus which has been paid to the men during the period from the inauguration of the fund. It has taught men habits of saving who never saved before, and has cemented the relations between the employees interested and the corporation. At the same time, it has not limited the scale of wages, as the ruling scale of wages, based upon the general law of supply and demand in London, has been applied; the rate of wages and the hours of employment being on a par with others of similar employment where such profit-sharing plan is not in vogue.

A similar plan has been adopted by the Boston Consolidated Gas Company, going into effect on September 20, 1906. The plan follows the lines of the South Metropolitan Gas Company, with some modifications. Premiums are to be calculated on the annual salaries of yearly earnings of the employees at the same rate as the dividends for that year on the stock of the company. The first premium was to be at the rate of seven per cent per annum, the present dividend of the company, with gas at 90 cents per thousand cubic feet. The detail of this plan is published in the issue of *Progressive Age* of October 15, 1906. Practically, in all respects, it is a copy of the plan, as stated above, of the South Metropolitan Gas Company, the principle of the London Sliding Scale, which has been adopted in Boston, being applied to the profits to be given to the employees.

BENEFICIAL SOCIETIES

As to the beneficial societies, or relief funds, we have considered more particularly the plan of the Pennsylvania Railroad Company, which, we understand, is the form adopted by other

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railroads, and which has been in existence since 1886. The purposes of the fund can be better explained by quoting from their own book on the description of their relief department, Section 2, which is as follows:

"The Relief Fund is a fund formed chiefly of regular monthly contributions by employees, who, while so contributing, are styled 'Members of the Relief Fund,' constituting a Mutual Beneficial Association.

"The fund also includes income or profits from investments, appropriations by the company, and gifts of legacies for the use of the fund.

"From this common fund the members are entitled to receive definite amounts, proportioned to their contributions, when disabled by accident or sickness, and in the event of their death certain definite amounts are payable to their relatives or designated beneficiaries."

The advantages of the fund are of course obvious to every one.

The enrollment is voluntary among the employees, and any employee, if not over 45 years of age, may, on application, become a member upon passing a satisfactory physical examination. Wherever it is possible the men are induced to join the organization.

The relief fund from which benefits are paid is composed of voluntary contributions from employees; appropriations by the company to make up deficit, if such deficit occurs; income or profit derived from investment of the moneys of the fund, and such gifts or allowances as may be made to the fund. The company agrees to take general charge of the voluntary relief department; to guarantee the fulfillment of the obligations assumed by the fund in conformity with the regulations from time to time established; take charge of the funds and be responsible for their safe keeping; supply the necessary facilities for conducting the business of the relief association, and to pay all the operating expenses thereof.

There are five classes in the fund, which are divided according to the amount of salary received, and the contributions per month vary with the salary, as follows:

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	Per Month
First class, any rate of pay	$0.75
Second " those receiving $35.00 or more	1.50
Third " " " 55.00 " "	2.25
Fourth " " " 75.00 " "	3.00
Fifth " " " 95.00 " "	3.75

These rates are not varied from, and there are no extra assessments on account of demands upon the fund.

Any employee, not over 45 years of age, may enter or change to a class higher than that determined by his usual earnings, upon passing a satisfactory physical examination if he shall have been a member of the relief fund one year and continuously in the service for five years, both immediately prior to the time of application to enter the higher class.

The members are entitled to the following benefits:

PAYMENTS FOR EACH DAY WHILE DISABLED BY ACCIDENT IN THE COMPANY'S SERVICE

	For 52 Weeks	After 52 Weeks
First class	$0.50	$0.25
Second "	1.00	0.50
Third "	1.50	0.75
Fourth "	2.00	1.00
Fifth "	2.50	1.25

PAYMENTS WHILE DISABLED BY SICKNESS OR INJURY OTHER THAN ACCIDENT IN THE COMPANY'S SERVICE, FOR EACH DAY AFTER THE FIRST THREE DAYS.

	For 52 weeks	After 52 weeks
First class	$0.40	$0.20
Second "	0.80	0.40
Third "	1.20	0.60
Fourth "	1.60	0.80
Fifth "	2.00	1.00

PAYMENTS IN THE EVENT OF DEATH.

First class	$250.00
Second "	500.00
Third "	750.00
Fourth "	1,000.00
Fifth "	1,250.00

Any employee, upon passing a satisfactory physical examination, can take additional death benefits, as per the following table:

	Death Benefit of Class	Additional Death Benefit	Total Death Benefit
First class	$250.00	$250.00	$500.00
Second "	500.00	500.00	1,000.00
Third "	750.00	750.00	1,500.00
Fourth "	1,000.00	1,000.00	2,000.00
Fifth "	1,250.00	1,250.00	2,500.00

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For each additional death benefit of the first class, the rates are as follows:

Taken at not over 45 years of age	.....	30 cents per month
" over 45 and not over 60 years	.... ..	45 " " "
" over 60 years	....	60 " " "

This rate is not increased on account of increasing age.

There are various details entering into the operation of this fund which your committee will be very glad to give to any of the members who desire the information, the purpose of this report being merely to explain the method adopted by the railroad system for the beneficial association.

The fund is in charge of the superintendent, who is subject to the control of the general manager, and with his approval employs the medical and clerical force. The superintendent is under the control of the advisory committee, which committee consists of the general manager of the company as member *ex officio* and chairman, and fourteen members, seven chosen by the directors of the companies and seven by the members of the relief fund, to serve for periods of one, two and three years respectively, and thereafter for periods of three years each. The seven committeemen, chosen by the members of the relief fund, are selected from the seven different divisions of the company, which divisions are included in the "Voluntary Relief Department," as their fund is called. It is the duty of the advisory committee to have general supervision of the operations of the department; arrange for investments of money not required to be kept on hand for current use; appoint persons to audit the condition of the fund each year; propose such amendments to or changes in the regulations as it may deem desirable; and act upon questions brought before it, by appeal from decisions of the superintendent or otherwise, respecting the rights and claims of members.

A particular and important feature in this fund for the benefit of the workmen was set forth in the statement made at Washington in regard to this department and the attitude of the company toward it, the charge being made that the relief department was maintained in the interest of the company and for the purpose of depriving members of their legal rights. We refer particularly to the guarantee of the fund by the railroad

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company, and, to more thoroughly explain this, we will quote from that report:

"In addition to these large contributions by the companies, there is the absolute guarantee of the companies that all just claims against the fund will be met when presented; this alone is a very valuable consideration, especially when considered in connection with the very small amount of cash on hand, equivalent to less than one per cent. of the risk of over $47,000,000 liability for death of members. This condition would be impossible with an ordinary co-operative beneficial organization, as the state insurance departments would not allow any organization of this character to continue with such a slender reserve fund. This guarantee is of incalculable value when considering the possible distress that would ensue in case of a serious epidemic, if it were not for the companies' guarantee to make good any and all deficiencies, and can be better appreciated when one recalls the numerous failures of other mutual beneficial organizations to meet their obligations."

The value of this can be fully appreciated, as well as also the fact that every dollar contributed by the members is returned to them in benefits, and that every cent of expense, as stated in the early part of this report, for conducting the department, of any character whatever, is paid by the companies.

We might also add in this connection that the records of the funds, as stated in the report mentioned, show that "the amount paid for accident, disablement and death from accident equals less than one-half of that paid for disablement and death from sickness."

We attach hereto a copy of the statement made by the officers of the Pennsylvania Railroad Company, covering their voluntary relief department, which was made at Washington during the consideration of the "Bates bill," at, we believe, the last session of Congress. This is a very interesting statement, and we shall be glad to furnish copies to any members of the committee desiring it.

SUPERANNUATION FUND.

As to the superannuation fund, which is a part of this relief fund, it can be tersely summed up as follows:

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The surplus accumulated as a result of the establishment of this fund is securely invested and the proceeds applied to what is termed the "Superannuation Fund." This fund applies to employees who have been retired on account of age from the company's pay-roll, and is paid in addition to the pension (a short statement of which follows), which the company pays out of its own treasury irrespective of the allowances from the fund.

The superannuation benefits are determined by multiplying the number of each class in which he shall have been a member by the number of full calendar months during which he has subscribed to each class respectively. The sum of the results thus obtained is the rate in cents of monthly allowances. It can readily be seen that this allowance is a very small one, comparatively. If a man has paid for 20 years in Class 1, he will receive an allowance of only $2.40 a month, and varying from that amount to $12 per month in the case of a man who subscribed for 20 years to the fund in the highest class.

PENSION.

This pension is paid entirely by the company and has nothing to do with the voluntary relief department. The pension is determined as follows:

An average is taken of the salary paid during the last 10 years of service. One per cent. of this average for each year in which the employee has been in the service of the company constitutes the pension paid him until death.

Retirement upon pension becomes obligatory when an employee reaches 70 years of age, and pension is given to any one reaching that age, irrespective of term of service, and is determined as per above regulations.

Any employee between the ages of 65 and 70, who has served 30 or more years, can apply for retirement and pension, which is granted if in the opinion of the employing officer he is incapacitated for further service.

We find in our examination of the subject that the South Metropolitan Gas Company, which is referred to in this report, has also a relief fund, practically the only difference being that in the event of death a further assessment is made upon each

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employee in the establishment or station in which the deceased member of the fund was employed.

BENEFICIAL ASSOCIATION OF THE PHILADELPHIA ELECTRIC COMPANY.

It will probably be more interesting to the members of this committee to relate the experiences gained in Philadelphia by the operation of a beneficial association, as it applies directly to the class of corporations in which we are engaged.

This association has practically been in existence since 1887, and was originally started by the Brush Electric Light Company.

Under this plan the assessment to be paid by each member was one per cent. of his regular monthly pay as rated; the company contributing each year a sum equal to the aggregate of the sums contributed by the employees.

During the period of the existence of this association the members and the company have been thoroughly satisfied with the results, and in but few cases have any members of the association or their families sued the company for damages for accident or death.

This association has been operated on limited lines, and at the end of the year 1906 the membership was but one-fourth of the employees of the company. It is proposed to enlarge the association to take in all the employees of every class of the Philadelphia Electric Company, and fix the amount that the company is to contribute, the details of which will follow. With this in view, meetings have been held with the members of the existing association, who have unanimously consented to the changes and are willing to join the enlarged association.

The object of the association is the establishment and management of a fund, known as the "Beneficial Fund," and the payment of definite amounts to members of the association who are entitled thereto by reason of disability from accident, sickness or other cause, and in the event of their death.

The members shall be only employees of the Philadelphia Electric Company, or of its affiliated, controlled or leased companies. Membership shall be forfeited upon a member leaving or being discharged from the service of the company. Applica-

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tion for membership shall be in writing in the form which has been prepared, and which contains all the conditions of membership, a copy of which will be found in the Regulations hereto attached.

Fees and Dues

An initiation fee of $1.00 to accompany application. Each member whose monthly salary or wages shall amount to $100 or more shall pay the sum of 75 cents as semi-monthly dues; and each member whose monthly salary or wages shall be less than $100 shall pay semi-monthly dues equivalent to one-half of one per cent. of his monthly salary. These dues shall be deducted or retained from the wages of the member by the treasurer of the Philadelphia Electric Company, and shall be delivered semi-monthly to the treasurer of the association.

The Philadelphia Electric Company assumes all the expense of clerk hire, office room, and all charges for stationery, and so forth, and shall facilitate in every way, without any charge therefor, the investment and handling of the relief funds, from time to time, for the benefit of the association. The Philadelphia Electric Company shall further contribute to the said fund to the extent of a sum equal to the amount from time to time contributed by the employee members of the association, until the total sum contributed by the members and the company shall aggregate the sum of $25,000; after which time the Philadelphia Electric Company shall contribute a sum equal to but 50 per cent. of the amount contributed by the members. After the accumulated fund shall amount to $50,000, the sum to be contributed by the company shall be an amount equal to 10 per cent. of the sum contributed by the members, until such time as the accumulated fund shall amount to the sum of $100,000, after which time the company shall make no contributions, except at such times as the fund shall fall below $100,000, and until the said fund again reaches $100,000.

Sick Benefits

The benefits awarded each member of the association during sickness, other than that resulting from accident, shall amount to a sum equal to one-half of his regular wages, for a period not exceeding 10 weeks. Sick benefits will not be paid

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for a less period than one full week, but will be paid for fractional parts of any week exceeding that period.

Accident Benefits

The benefits awarded each member of the association in case of accident shall amount to a sum equal to the full amount of his regular wages and for a period not exceeding 10 weeks, except in cases of serious injury, in which case the period of benefits may be extended by vote of a majority of the trustees present at regular meeting; benefits to commence upon the first day of disability upon which no wages are paid.

In the event of any member of the association in good standing becoming permanently disabled, the trustees shall, by unanimous vote of all the trustees, at a regular meeting of the board, draw an order upon the treasurer of the association for a sum not exceeding the aggregate yearly wages of such member, such sum to be paid as soon as practicable after disability.

Death Benefits

In the event of the death of any member, the treasurer of the Philadelphia Electric Company is authorized, at the request of the trustees, made through the superintendent, to deduct 50 cents from the wages of each member of the association and pay the same to the treasurer of the association, who shall in turn pay it to the beneficiaries named in the application of the member. If this assessment of 50 cents per member shall amount to a sum exceeding $500, the assessment *per capita* shall be reduced proportionately, so that the total amount collected by any one assessment shall not exceed $500. And the Philadelphia Electric Company will contribute a sum equal to one-half of the aggregate amount deducted from the wages of the members as above stated. If the deceased member shall have been an employee of the company for five consecutive years, an additional sum of $250 shall be paid by the treasurer of the association, in addition to the death assessment and the contribution of the Philadelphia Electric Company. It will be observed that this death benefit is an insurance of $750, and in the case of an employee in active service for five years, $1,000.

A part of the death benefit may be paid before the final

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settlement, to meet funeral and other urgent expenses, to an amount not exceeding $125.

Should a member, or his legal representative, or any other person authorized by law, bring suit against the Philadelphia Electric Company for damages on account of injury or death of such member, payment of benefits from the beneficial fund on account of same shall not be made until such suit is discontinued. If prosecuted to judgment or compromised, any payment of judgment or amount in compromise shall preclude any claim upon the association for such injury or death.

The officers of the association shall be a superintendent, a treasurer and a secretary, who shall be appointed annually by the president of the company. There shall also be a board of eight trustees, employees of the company, who shall be chosen by ballot at the annual meeting of the association. Members of the board of trustees to serve during the first year shall be chosen by the president of the company, and in case of vacancies thereafter during the year they shall be filled by the superintendent of the association, and serve until their successors are duly chosen.

For the information of the committee, a copy of the Regulations, which are now in general operation in Philadelphia, is attached hereto.

UNITED TRACTION EMPLOYEES' MUTUAL AID ASSOCIATION, PROVIDENCE, R. I.

This association was formed by the United Traction and Electric Company for the employees of companies owned, operated or controlled by it, for the purpose of affording aid and relief to sick and disabled members, and to the widows and children of deceased members. All employees making weekly contributions are members of this association; elective officers and temporary laborers on construction work are excluded.

The management of this association is vested in seven persons: four chosen by the directors and three by the members from their own number by ballot. Each member is entitled to one vote, with his name endorsed thereon, and the members having the largest number are declared elected. If a vacancy exists in the number of trustees chosen by the directors, said

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vacancy is filled by the remaining trustees chosen by the directors; but if a vacancy occurs in the trustees chosen by the members, the remaining member trustees fill the vacancy. The organization is managed by a chairman, treasurer, secretary, and any additional officers at the pleasure of the board.

The members are divided into three classes, for the purpose of determining benefits and contributions.

First Class.—All members whose weekly earnings are less than $9.00.

Second Class.—All members whose weekly earnings are $9.00 or more but not so much as $12.

Third Class.—All members whose weekly earnings are $12 or more.

The first class contributes 10 cents each week.

The second class contributes 15 cents each week.

The third class contributes 20 cents each week.

Such contributions continue whether the member is working or on the sick or accident list.

Benefits at Death

First class	$500.00
Second "	750.00
Third "	1,000.00

One-half of the said amount is paid to the widow or husband; the other half to the children. If no children, then the whole goes to widow or husband. If no widow or husband, then to the next of kin according to law. Proviso is made that if the beneficiary is in receipt of a pension from any of the companies he can not participate in the death benefits, except the widow or husband of a member. The usual exceptions are also made that no benefits shall accrue to any person if any member's death is due wholly or in part, directly or indirectly, to the use of alcoholic liquors; the immoderate use of stimulants; violence, and so forth, or resulting from voluntary and unnecessary exposure to danger of injury, contagion or infection, unless in pursuance of duty as an employee. An exception is made to this in the matter of self-defense.

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Benefits in Case of Disability

First class	$4.00 per week
Second "	6.00 " "
Third "	8.00 " "

Provision is made that if the total benefit insurance of any member exceeds his average weekly wages, then the amount received from this association is proportional as his weekly wages bear to his benefit insurance. No benefits are paid for disability arising from any of the causes specified in Section 3, and partly enumerated above. Members receive benefits for disability as long as it continues, or until such time as they become entitled to a pension.

Releases

In consideration of the contributions to be made to the funds by the company, there is no benefit paid either for death or disability except upon a receipt which contains a release in proper form to the said United Traction and Electric Company and the companies owned, operated or controlled by it. If any member, or any beneficiary of a member, shall make claim or bring suit against the company, or any company owned, operated or controlled, he shall not be entitled to any benefits from the association, unless the claim is abandoned and withdrawn, or such suit is discontinued without trial. Any payment, compromise or settlement of any claim, or of any judgment under such suit, cancels and nullifies all the rights of such member or beneficiary to any benefits from this association.

Proofs of Death or Disability

Proofs of death or disability must be furnished within 30 days after death or after the commencement of such disability, and the benefits accrue from the date of notice only. The members must permit a physician or physicians selected by the association to examine them, and a refusal forfeits the right to further benefits until such examination is permitted. A majority of the trustees rule on all matters of every kind and nature presented to them, and the members have the right of appeal to the said board from decisions given by any person or persons to whom power may be delegated.

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Application of Surplus Funds

The board can apply any surplus funds in any one or more of the following ways:

First.—To pay partial benefits for partial disability.

Second.—To increase the benefits for death or disability, or both.

Third.—To diminish the contributions of the members, ratably.

Forfeiture of Membership and Benefits

By virtue of the contract between the association and the United Traction and Electric Company and the Rhode Island Company, by virtue of its assumption of the traction contract, it is expressly declared that any member who shall cease from any cause to be an employee of said company or companies, or some of them, shall thereupon cease to be a member of this association; and that he and each and every one of his beneficiaries shall thereupon forfeit all right, title and interest he or they had in or to funds held by the association. There is a proviso that temporary suspension, or absence from duty on leave, shall not be construed as a termination of a member's employment.

The contract between the company and the association is attached hereto, marked "Exhibit D" (see pages 613 to 616).

The salient features of this contract are that the company agrees to contribute to the funds of the association as follows, *viz.*:

(1) In the case of death,

First class	$100.00
Second "	150.00
Third "	200.00

(2) One-fourth of the amount of contributions by the members, payable weekly as the said amount may be determined.

(3) Amounts, from time to time, sufficient to meet the current expenses of management, including expenses of adjusting and litigating claims.

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(4) Amounts to make up any deficiencies, provided that such contributions for any such deficiencies shall be repaid out of any surplus that may thereafter be accumulated.

The traction company deducts the contributions of the men from their wages.

It will be interesting to note some of the data gathered from the report of this association for the year 1906.

The disability claims paid amounted to.....	$22,676.45
The death claims	10,625.00

of which the members contributed only $14,690.95, and the company $19,272.75.

Since the organization, death claims have been paid amounting to $47,250, and disability claims, $89,363.89, of which the members contributed $75,675.25 and the company $62,118.85.

The entire expenses of the management having been met by the company, said expenses do not appear in their report, and are in addition to the amounts noted above.

It is noted in said report that the larger part of the disability benefits have been for short illnesses; but, from the few cases of long disablements, it is a pleasure to note that the benefits received are supporting the disabled members decently, though economically, at a sanatorium and affording them every chance for recovery.

Pension System

As an adjunct to the above association, but dissociated from it, is a pension system paid entirely by the railroad company, the salient points of which are as follows:

Every employee reaching the age of 70 years must retire from service, and he will receive a pension according to time of service, as follows, *viz.*:

For less than twenty years, one per cent. of his average wages for the 10 years immediately preceding, for each year; thus, a man earning $600 per year, who had been in the employ of the company for 19 years, would be entitled to a yearly pension of $114.

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For 20 years and up to 25 years	1.25	per cent. per year	
" 25 " " " " 30 "	1.50	" "	
" 30 " " " " 35 "	1.75	" "	
" 85 "	2.	" "	
" each year above 35 years	2.	" "	but not to exceed 100 per cent. in all

No one is employed over 35 years of age.

Each applicant must submit to a physical examination, for which he must pay the physician's fee of $1.00, which he forfeits whether accepted for service or not.

On the inauguration of the system all employees were eligible to membership in the association, without regard to physical condition.

RESULTS OF THE OPERATION OF AN EMPLOYEES' ASSOCIATION OF A LARGE PUBLIC-UTILITY CORPORATION, INCLUDING RESULTS OF MORTUARY AND SICK-BENEFIT FUNDS.

MORTUARY FUND

Balance, January 1	$3,788.40	$6,024.3
RECEIPTS		
Dues, etc., to December 31	6,561.00	6.817.00
Members' receipt-books	.20	.10
——— Co., contribution	3,162.50	3.360.25
——— Co., medical examiner's car-fare	19.25	
——— Co., interest on investment	1,049.10	1.260.62
——— Trust Co., interest	76.18	73.65
	$14,656.63	$17,535.99
DISBURSEMENTS		
Death benefits paid (21), (23)	$6,300.00	$6,900.00
Refunded dues, members leaving companies' employ	259.50	355.00
Salaries—secretary, treasurer and porter	100.00	134.00
Financial secretary's refunded dues	120.00	127.00
———Co., for investment	1,500.00	4,506.25
Financial secretary, expenses, car fare, rent, printing, postage, bonding, officers, financial secretaries, etc	154.51	117.62
Medical examiner's fees, etc	198.25	111.00
Balance, December 31	6,024.37	5,285.12
	$14,656.63	$17,535.99

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FRIENDLY AIR FUND.

Balance, January 1	$3,417.24	$1,473.17
RECEIPTS		
Dues, etc., to December 31	2,987.60	3,564.30
——— Co., contribution	1,374.30	1,724.00
——— Co., medical examiner's salary and car-fare	122.80	1,994.55
——— Co., interest	106.04	116.75
——— Co., overpayment account investment	165,00	.....
Sick benefits, overpayment	7.00	.....
——— Trust Co., interest	30.84	22.15
	$8,210.82	$8,894.92
DISBURSEMENTS		
Sick benefits paid (474), (683)	$3,083.00	$4,338.00
Refunded dues, members leaving companies' employ	334.40	429.60
——— Co., for investment	2,500.00	.....
Medical Examiner's salary	175.00	1,790.00
" " "	.....	213.00
Salaries—secretary, treasurer and porter	100.00	134.00
Financial secretary's refunded dues	72.00	76.20
Medical and surgical supplies	296.13	332.36
Medical examiner's car-fare	33.80	79.55
Financial secretary, expenses, car-fare, rent, printing, postage, bonding, officers, financial secretary, etc	143.32	209.05
Balance, December 31	1,473.17	1,263.19
	$8,210.82	$8,894.92

RELIEF FUND

Balance, January 1, 1906		$745.50
RECEIPTS		
Entertainment, December 15, 1905 (expenses ded.)		412.00
" " 14, 1906 (to date)		1,074.00
Account loans		30.00
——— Trust Co		26.82
		$2,288.32
DISBURSEMENTS		
T. McD., relief	$15.00	
Expense, account entertainment, December 15, 1905	8.00	
P. K., relief	6.00	
T. McD., relief	12.00	
M. S., relief	6.00	
Expense, deposit account hall for December 14, 1906	25.00	
W. B., relief	5.00	
Expense, account entertainment, December 14, 1906	4.00	
Loan, L. R. W., at five per cent	125.00	
Loan, J. F. K., at five per cent	150.00	
J. J., relief	30.00	
P. K., relief	12.00	
Expense, account entertainment, December 14, 1906	657.60	
		$1,055.00
Balance, December 31, 1906		$1,232.72

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SUMMARY OF DISBURSEMENTS

Account relief	$86.00	
Loans	275.00	
Expenses, account entertainment	694.60	
Total		$1,055.60

SUMMARY OF CASH

	1905		1906	
Mortuary Fund:				
Amount invested with ——— Co., at five per cent.	$21,119.58		$25,625.83	
Cash on hand, ——— Trust Co	6,024.37	$27,143.95	5,285.12	$30,910.95
Friendly Aid Fund:				
Amount invested with ——— Co., at five per cent.	$2,335.00		$2,335.00	
Cash on hand, ——— Trust Co	1,473.17	$3,808.17	1,293.16	$3,628.16
Total, Mortuary and Friendly Aid funds		$30,952.12		*$34,539.11
Relief Fund:				
Cash on hand, ——— Trust Co		745.50		1,232.72
Total in three (3) funds		$31,697.62		$35,771.83

* The increase during the year is $1,497.26 less than the amount contributed by the ———Co. during the year 1906 ($5,084.25, not including interest, $1,377.37; and medical examiner's salary and car-fare, $1,994.55).

This proves that more money is being expended than the members are contributing, and if it were not for the generosity of the ——— Co. we would show at the end of the year a deficit instead of an increase.

SUMMARY OF DEATH BENEFITS PAID—1891-1906

1891	2 deaths		$600.00
1892	13 "		3,900.00
1893	9 "		2,700.00
1894	15 "		4,500.00
1895	12 "		3,456.20
1896	13 "		4,043.80
1897	18 "		5,400.00
1898	13 "		3,900.00
1899	19 "		5,700.00
1900	18 "		5,400.00
1901	20 "		6,000.00
1902	18 "		5,400.00
1903	19 "		5,700.00
1904	26 "		7,800.00
1905	21 "		6,300.00
1906	23 "		6,900.00
Total	259 deaths	Total	$77,700.00

Average deaths, first five years	10 1/5
" " second " "	14 1/5
" " third " "	20 4/5
" " last six "	21 1/6
Average deaths per year	16 3/16

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During the year 25 deaths were reported, of which 23 have been promptly paid. Two deaths remain unpaid; papers were not received in time to pay these deaths in 1906, but since January 1, papers have been received and the claims are in due course of payment.

Of the 23 deaths paid, 19 are what we call original members; that is, members who have joined the society between February, 1901, and February, 1902, leaving 4 deaths among those members who underwent a medical examination (and were admitted to membership on such examination) since the revision of the constitution and by-laws in 1902. Since 1902, 107 members have died, 5 having been admitted upon the result of the medical examination and 102 as original members.

The beneficiaries of these deceased (23) members received $6,900, and the total amount paid by these members was $1,563, or 22.65 per cent. of the benefits received. The average payment by these members was $67.93.

The largest amount paid by a deceased member was $95, or 31.23 per cent. of one benefit; and the amount paid to the beneficiary for each $1.00 paid by this member was $3.154.

The smallest amount contributed by a deceased member was $14.50 or 4.5 per cent. of one benefit; and the amount paid the beneficiary for each $1.00 paid by this member was $20.69, or 7.14 per cent. of one benefit.

The average return for each $1.00 contributed by deceased members was $4.41.

The longest duration of membership of these deceased members was 14 years and 10 months.

The shortest duration of membership of these deceased members was 2 years and 5 months.

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LIST OF DECEASED MEMBERS—1906.

Book No.	Admitted	Age	Date of Death	Age	Cause of Death	Amount of Dues Paid
1861	April 10, 1903	34	Dec. 31, 1905	36	Pulmonary tuberculosis	$16.50
78	Feb. 17, 1891	34	Jan. 5, 1906	49	Cholæmia, cirrhosis of the liver, complicated with ascitis, hydrothorax and jaundice	90.00
1854	Feb. 19, 1903	32	Jan. 9, 1906	36	Pulmonary tuberculosis	18.00
256	Feb. 17, 1891	41	July 5, 1905	56	Syncope and nephritis	87.00
560	July 10, 1891	66	Feb. 19, 1906	81	Exhaustion, siguela of gangrene of feet	88.99
142	Feb. 17, 1891	50	Feb. 10, 1906	65	Arterial schescim and chronic endocarditis	90.50
718	April 20, 1893	47	Feb. 21, 1906	60	Pneumonia	65.50
554	May 21, 1891	55	May 14, 1906	70	Fractured skull	90.00
1554	Oct. 18, 1900	46	April 1, 1906	52	Heart diease	33.50
1040	June 20, 1895	26	May 31, 1906	37	Tuberculosis	50.00
305	Feb. 17, 1891	47	May 30, 1906	62	Carcinoma of liver	92.00
846	Jan. 18, 1894	44	June 20, 1906	66	Pulmonary œdema and valvular disease of the heart	63.00
621	June 10, 1892	38	July 11, 1906	52	Acute articular rheumatism and endocarditis	85.00
819	Oct. 19, 1893	29	July 23, 1906	42	Cancer of stomach	65.00
1683	Aug. 15, 1901	39	July 29, 1906	43	Asphyxia, aneurism arc of aorta	30.00
238	Feb. 17, 1891	25	Aug. 22, 1906	40	Pneumonia with typhoid fever	93.50
428	Feb. 17, 1891	59	Aug. 2, 1906	74	Mitral insufficiency	93.50
1941	Jan. 16, 1904	32	Oct. 10, 1906	32	Lobar pneumonia	14.60
201	Feb. 17, 1891	41	Nov. 1, 1906	56	Chronic endocarditis and nephritis	95.00
70	Feb. 17, 1891	55	Nov. 7, 1906	69	Hypostatic pneumonia	95.00
943	Aug. 16, 1894	36	Nov. 14, 1906	49	Chronic endocarditis and chronic nephritis	74.00
603	March 17, 1892	48	Nov. 19, 1906	62	Chronic nephritis	88.50
1764	March 20, 1902	45	Dec. 24, 1906	49	Pleuro-pneumonia	29.00
						$1,563.00

Average age at at date of admission, 42 3/23 years. Average age at date of death, 53 11/23 years.

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In 1902 the ——— Company began its contributions to the society, and since Februrary, 1902, it has contributed to the:

Mortuary Fund.	$15,558.00
Friendly Aid Fund	5,828.10
Medical examiners' salary.	7,365.00
Medical examiners' car-fare	174.25
	$28,925.35

On investments the company paid the society 5 per cent. interest, which amounted to $4,793.99; this amount, added to the $28,925.35, makes a total of $33,719.34. The interest the society would have received from other sources of investment, such as depositing its surplus fund in savings banks (its old method of investment), would have been from 3 to 3.5 per cent., so by investing its surplus funds with the company the society gains from 1.5 to 2 per cent. on its investments.

AMOUNT OF SICK BENEFITS PAID—1905-1906

	1905	1906	Increase	Decrease
January	$233.00	$370.00	$137.00	
February	368.00	416.00	48.00	
March	278.00	350.00	72.00	
April	300.00	414.00	114.00	
May	186.00	270.00	84.00	
June	207.00	276.00	69.00	
July	180.00	349.00	169.00	
August	201.00	338.00	137.00	
September	185.00	148.00	.....	$37.00
October	199.00	509.00	310.00	
November	315.00	437.00	122.00	
December	431.00	461.00	30.00	
Total	$3,083.00	$4,338.00	$1,255.00	

Average benefits paid per month during 1905	$256.92
" " " " " " 1906	361.50
" increase per month, 1906 over 1905	104.58

AMOUNT OF SICK BENEFITS—1902-1906

1902	21	benefits	$216.00
1903	205	"	1,601.00
1904	369	"	2,597.00
1905	474	"	3,083.00
1906	683	"	4,338.00
Total	1752	benefits	$11,835.00

TOTAL ATTENDANCE—MEDICAL EXAMINERS

	Medical	Surgical	Total	Estimated Financial Saving to Sick Members
1902	200	121	321	$800.00
1903	660	271	931	2,500.00
1904	1009	448	1457	3,500.00

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	Medical	Surgical	Total	Estimated Financial Saving to Sick Members
1905	1066	501	1567	4,000.00
Dr.	1740	548	2288	6,000.00
1906 Dr.	130	83	213	650.00
	4805	1972	6777	$17.450.00

This amount of estimated financial saving to sick members, $17,450, and the amounts $11,835 and $894.03 (sick benefits, medical and surgical supplies) expended since 1902, shows a total of $30,179.03. As we have an arrangement whereby we pay only 25 cents per prescription and the medical examiners allow the society the regular discount on all surgical supplies. this amount paid by the society for medicines, and so forth, should be increased 100 per cent, and it would still be a fair estimate of the amount the members would have to pay for medical and surgical supplies. This amount would then be $31,073.06.

The total membership of the Friendly Aid Fund during this period, 1902-1906, has contributed in dues, and so forth, $12,-683.53. This shows a fair estimate saving of $18,389.53 (to sick members) on the total membership's contribution. Thus far only (about) one-third of the membership of the Friendly Aid Fund have derived the benefits of this fund. Should this seem unfair tothose remaining members who have had as yet no occasion to resort to these advantages, let them consider that, should the need arise, they also will receive the same benefits.

The following figures will show approximately the cost per visit of our medical examiner since 1902:

Total visits, 6777.			
Sick benefits	$11,835.00		
Medical examiners	7,365.00		
" "	213.00		
Medical and surgical supplies	894.03		
Car-fare medical examiners	174.25		
*Sundry expenses	1,000.00		
	$21,481.28	Per visit	$3.1706
Including refunded dues	1,283.20		
	$22,764.48	" "	3.591
Sick benefits, medical examiner's supplies and car-fare	$20,481.28	" "	3.0222

* Year 1902-4—taken from the expense fund, since abolished.

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TOTAL AMOUNT OF DUES REFUNDED TO MEMBERS LEAVING THE ——— COMPANIES' EMPLOY—1902–06

	Mortuary	Friendly Aid	Total
1902	$18.00	$24.00	$42.00
1903	137.00	167.10	304.10
1904	169.00	328.10	497.10
1905	259.50	334.40	593.90
1906	355.00	429.60	784.60
Total	$938.50	$1,283.20	$2,221.70

SICK BENEFITS PAID SINCE 1902

1902–5	$7,497.00
1906	4,338.00
	$11,835.00

COST PER MEMBER—FRIENDLY AID FUND, YEAR 1906

	Total Cost	Cost per Member
Sick benefits paid	$4,338.00	$4.6002
Printing, postage, car-fare, etc.	209.05	.2217
Physicians	1,878.00	1.9915
Medical and surgical supplies	332.36	.3524
Car-fares of physicians	79.55	.0843
Refunded dues, members leaving companies' employ.	429.60	.4556
" " financial secretaries	76.20	.0808
Salaries, secretary, treasurer and porter	134.00	.1421
	7,476.76	$7.9286
Dues per member		$3 6000
——— Co., contribution (one-half)		1.8000
——— Co., salaries of physicians		1.7656
——— Co., car-fares, "		.0843
——— Co., interest		.1473
New members		.0970
Total		$7.4942
Deficit		.4344
Average membership	943	
Membership end of 1906—Mortuary Fund	1,102	
" " " " Friendly Aid Fund	955	

BOSTON ELEVATED RAILWAY COMPANY.

This company has adopted a system of paying $15.00 to each employee wearing a blue uniform who has rendered continuous and satisfactory service throughout the calendar year, and to new employees who have been in continuous employment six months prior to the end of the calendar year. This is intended as a reward for meritorious service only.

They have adopted a plan, however, for the support of aged employees wearing the above-mentioned blue uniform,

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it being left entirely to the judgment of the management whether or not said employee is unfit to perform any duty in the service of the company. The plan is as follows: If an employee has been continuously in the service of the company for a period of twenty-five years, or has reached the age of sixty years and been continuously employed by the company for fifteen years, the company contributes to the support of such employee a sum not exceeding $25.00 per month during the rest of his lifetime. It would appear from this that the amount to be paid is also left entirely to the judgment of the management.

In addition to the above, they have a regular system of extra compensation for service stripes of the men wearing blue uniforms. One service stripe is awarded for each five years of continuous service. On stripe gives the employee an extra half cent per hour; two stripes, one cent; three or more stripes, one and a half cents per hour, and is added to the regular rates of pay governing employment in the car service and includes inspectors, starters, station masters, collectors, and all other blue uniformed men in both surface and elevated service.

Since the adoption of the above plan in 1903, about fifty employees have been pensioned.

The following clippings from *Progressive Age* show the profit-sharing plans adopted by the New Haven (Conn.) Gas Light Company and the Milwaukee Gas Light Company:

"It is said that the New Haven (Conn.) Gas Light Company has adopted a profit-sharing plan by which its 265 employees who have been in service for one continuous year will receive, quarterly, a share of the company's earnings equal to eight per cent. of their wages. This is at the same rate at which dividends are paid to the stockholders. The plan also includes the accumulation of this advance in their wages, and when the eight per cent. dividend on their wages amounts to the market value of one share of stock, the same will be credited to the employee. This scheme, it is reported, will go into effect April 1, when the eight per cent. will be given to all employees of one year's standing for the preceding three

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months of their labors. The executive officers will not participate in this plan."

"The annual bonus to its employees by the Milwaukee (Wis.) Gas Light Company amounted for the past six months, to 10 per cent. of their wages instead of 6 per cent. as heretofore. General Manager Glass said: 'Since our employees have been factors in producing our prosperity by increasing the efficiency of our service to our customers, we desire that they should share in the profits. Every employee, except the executive officers, shares in the bonus, no distinction being made in the grade of workmen. The office force, solicitors, and the men at the works, meter shops and tar plant, share alike. The only condition is that employees must have been in the company's service for a year previous to, and regularly during, the period for which the bonus is given.'"

THE ITALIAN FUND.

Insurance must be provided for all those who, either permanently or temporarily, are occupied for a daily wage, or on piece-work, away from their homes; those who, although not participating directly in the work, superintend the work of others, provided their fixed wage does not exceed seven lire ($1.34) per day, payable in regular periods not exceeding one month; also apprentices who take part in the work, with or without wages; and attendants on agricultural machinery.

All employers of labor have to insure against accidents. If the job is not permanent, an insurance has to be effected to cover the time it lasts. Fines are imposed on employers who attempt to deduct the cost of insurance from the operatives' wages or make an incorrect declaration as to the number of employees.

Insurance must be effected with the National Fund; but there are exempted from this form of insurance, firms who have instituted, at their own cost, private funds recognized by Royal decree and who have deposited with the National Fund various sums based upon various conditions.

In all accidents the employer has to bear the cost of first aid, and in case of death the indemnity is equal to five years' wages, divided as follows: two-fifths to the wife and three-

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fifths to the children who are under eighteen years of age. In the case of absolute permanent incapacity for work, the compensation is equal to six years' wages, with a minimum of $600. In the case of partial, but permanent, incapacity for work, the compensation is equal to six times that part of which the wages are reduced, or may be reduced, subject to a minimum of $100. Should the incapacity for work be complete, but, nevertheless, temporary, the sum to be paid is equal to one-half the daily pay the employee received at the time of the accident. If the accident has caused partial and temporary incapacity for work, the daily compensation is equal to half the reduction in the daily pay.

Indemnity to apprentices is based upon the wages of the lowest-paid operatives engaged on the same work.

The "annual wage" is defined as meaning "that paid during the twelve months preceding the accident, in cash or in truck, up to a maximum limit of $400."

There are a lot of detail provisions in the law, which, as is said in the article, is no doubt one-sided. It also calls attention to the fact that many frauds have been perpetrated since the law went into effect in January, 1904. It seems that workmen get injured willingly with the view of receiving compensation in cash. Firms who have always been liberal towards their employees do not seem to be able now to cope with the increase in accidents and claims for compensation.

The writer of the article gives his experience as follows:

"The experience gained on the subject in our own works is to the point; we have about 1,800 operatives, and at the present time the increase in claims for compensation under the law is 40 per cent. over the figure of several years ago, when we, of our own free will and without state compulsion, insured our men, and when a large number of protective devices to prevent accidents, now in use, were unknown." According to another report, the number of accidents caused by engines, lifts, motors, and shafting has decreased of late, while the number of falls and accidents in hand-labor have doubled, many other claims being for cases of arthritis and rupture, traced invariably by the men to their work for the employers, and for which they

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claim the benefit of the law, aided in this by unscrupulous medico-legal advisers.

"The National Provident Fund, above referred to, was formed in July, 1898; it is governed under a law dated July, 1901, completed by statutes and regulations approved by Royal decree of May, 1902. All Italian subjects are free to pay deposits into the fund for securing an old-age pension or a pension in case of disablement, and the state has endeavored to encourage thrift on the part of the subjects, not by adding a given percentage to the individual deposits made by them as is the case in Belgium, but by paying subsidies direct to the fund. Thus the state, in the first place, endowed the fund with $2,000,000 from sums in the treasury from savings and deposit accounts, and also part of the profits of the Post Office savings bank. Various other payments and contributions have been, and are being, made to the fund in question; among others may be mentioned a tenth part of the credit for public worship."

EXHIBIT "A"

General Agreement *Wages. No.* *Profit-sharing No.*

MEMORANDUM OF AN AGREEMENT made the ..... day of ..... 190 .... between ..... for and on behalf of the SOUTH METROPOLITAN GAS COMPANY, of No. 709, Old Kent Road in the County of Surrey, of the one part, and ..... of the other part.

1. The said ..... for South Metropolitan Gas Company agrees to employ said ..... for a period of ..... months from the day of the date hereof at one or other of the Stations of the said Company, if he shall remain sober, honest, industrious and performs the work allotted to him.

2. The said ..... agrees to serve the said Company for the said period of ..... months in whatever capacity he may from time to time be employed by the said Company at the current rate of wages applying to such capacity.

3. The said ..... agrees to obey the orders of the Foreman in charge.

4. The hours of working for yard men to be 54 hours per week.

5. The Company undertakes that during the continuance of this Agreement the different rates of wages in force at the date hereof, and which, under Clause 2, may become payable to said ..... shall not be reduced.

6. The said ..... to be entitled to the benefit and be bound by the conditions of the Profit-Sharing Rules so long as he shall continue in the service of the Company under agreement.

No obstacle will be thrown in the way of any man engaged under the above contract who may wish to leave the company's employment before the expiration of the period of service therein agreed for, provided he shall notify such wish to the

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engineer of the station at which he may for the time being be employed, and on receipt of such notice the engineer shall, in his discretion, consider whether the services of such man can be dispensed with without detriment to the company, and, if so, permission will be given at the expiration of the usual week's notice.

EXHIBIT "B."

Statement showing the contributions made by members of the Pennsylvania Railroad Voluntary Relief Department and the Companies associated in administration thereof—also the disbursements in benefits and assistance rendered to the members.

The Pennsylvania Railroad Voluntary Relief Department is composed of the various Companies associated in the Pennsylvania Railroad system and for convenience of designation is known as the Pennsylvania Railroad Voluntary Relief Department.

It is managed by an Advisory Committee consisting of fourteen members, seven of whom are chosen by the members and seven chosen by the Companies, with the General Manager as *ex-officio* member and chairman of the committee.

During the almost twenty years of operatoin of the Department, namely, from February 15, 1886, to December 31, 1905, there was contributed:

By members the amount of	$14,354,422.14
By the Companies for special payments in 1886	60,652.86
By the Companies to December 31, 1899, for Relief to sick members who had exhausted their title to benefits	363,919.05
By the Companies for deficiencies, February 15, 1886, to December 31, 1905	586,629.80
By the Companies for operating expenses, such as salaries of all employees of the Relief Department, Rental, supplies, etc.	2,203,719.25
By the Companies, Interest on monthly balances and investments, February 15, 1886 to December 31, 1905, at the rate of 4 per cent	503,422.15
Total by members, Companies and interest	$18,072,765.25

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In addition to the above cash payments to the Fund by the Companies, the expenses of office rent for Medical Examiners, and their supplies, the services of numerous other employees all over the system, in all departments, including the facilities of the mail, express and telegraph departments, free hospital services, surgical attendance, and the furnishing of artificial limbs, trusses and other appliances, furnished to disabled members by the Companies, it is estimated equal 75 per cent. of the cash paid by the Companies for the maintenance of the Fund—this would amount to $1,652,789.44, which added to the total receipts makes the total:

			$19,725,554.69
	Add also donations		5,005.25
	Making the Grand Total		$19,730,559.94
	The disbursements of the Fund have been as follows:		
3007	accident death benefits paid from February 15, 1886, to December 31, 1905	$1,655,631 56	
7420	sickness death benefits paid from February 15, 1886, to December 31, 1905	4,235,745.77	
149,379	disablements by accident from February 15, 1886, to December 31, 1905	2,853,304.24	
451,718	disablements by sickness from February 15, 1886, to December 31, 1905	5,591,010.29	
	Superannuation allowances paid to retired members from Superannuation Fund, January 1, 1900, to December 31, 1905	251,929.51	
	Expenses paid by Companies for operating the Department,	2.203,719.25	
	Additional cost of services and facilities for conducting the Department, not included in above, including such as hospital attendance, surgical attendance, artificial limbs, etc., and other expenses (estimated)	1,652,789.44	
	Total		$18,444,130.06
	Leaving a balance on hand		$1,286,429.88

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From the above it is shown that the payments by the Companies were as follows:

Expenses paid by the Companies for operating the Department	$2,203,719.25
Expenses paid by the Companies, estimated cost of services and facilities for conducting the Department, including hospital attendance, surgical attendance, artificial limbs, etc., and other expenses not included in above	1,652,789.44
Deficiencies paid by Companies	586,629.80
Special payments by Companies in 1886	60,652.86
Relief to sick members who had exhausted their title to benefits	363,919.05
Total	$4,867,710.40

OPERATIONS FOR THE YEAR 1905.

Amount of contributions by members, 1905		$1,410,784.02
Interest on monthly balances and investments, 1905		49,829.78
Deficiencies paid by Company, 1905,	$92,824.79	
Operating expenses, 1905	196,286.81	
Total paid by Companies, 1905		289,111.60
Total by members, Companies and interest 1905		$1,749,725.40
Accident Death Benefits paid, 1905	$180,840.90	
Sickness Death Benefits paid, 1905	352,035.12	
Accident Disablement Benefits paid 1905	312,710.25	
Sickness Disablement Benefits paid 1905	555,237.14	
Superannuation allowances paid retired members, 1905	54,318.12	
Total Benefits paid, 1905		$1,455,141.53

By analyzing these statements it will appear that the number of deaths from accident is less than one-half the number of deaths from sickness, and the number of disablements by accident less than one-third that of disablement by sickness,

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and the amount paid for accident disablement and death from accident, equals less than one-half of that paid for disablement and death from sickness; therefore, the claim that the Relief Department is maintained principally for the purpose of depriving members of their "legal rights" is without foundation. It should also be borne in mind that of the many accidents reported, comparatively very few would disclose any liability on the part of the Company for damages.

From the foregoing statement showing the operations for the twenty years ending December 31, 1905, it will be seen that the cash paid directly for operating expenses, deficiencies and supplies, together with the estimated amount for expenses not directly charged to the Relief Department, equals about 25 per cent. of the total amount contributed by both the members and the companies, and would equal about 34 per cent. of the amount contributed by the members.

In addition to these large contributions by the Companies, there is the absolute guarantee of the Companies that all just claims against the Fund will be met when presented; this alone is a very valuable consideration, especially when considered in connection with the very small amount of cash on hand, equivalent to less than 1 per cent. of the risk of over $47,000,000 liability for death of members. This condition would be impossible with an ordinary co-operative beneficial organization, as the State Insurance Department would not allow any organization of this character to continue business with such a slender reserve fund. This guarantee is of incalculable value when considering the possible distress that would ensue in case of a serious epidemic if it were not for the Companies' guarantee to make good any and all deficiencies, and can be better appreciated when one recalls the numerous failures of other mutual beneficial organizations to meet their obligations.

Deducting from the total amount paid by the Companies, *viz.*: $4,867,710.40, the difference between the amount contributed by the members and that paid to them for benefits, *i. e.*, $18,730.28, would show a deficit in the accounts of the Department to December 31, 1905, amounting to $4,848,980.12, that would have existed had it not been for the liberality of the Companies. Instead of this deficit there is to the credit of the Fund to December 31, 1905:

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In Relief Fund Surplus Account the interest from which is paid to retired members as "Superannuation"	$751,256.25	
In Superannuation Fund Account	70,726.27	
Total		$821,982.52
Current accounts from which benefits for disability and death are payable		464,447.36
Grand Total		$1,286,429.88

It is provided in the regulations of the Relief Department that in the adjustment of the accounts between the companies and the fund the financial periods should be of three years each. At the close of every three years the accounts are closed. If there is a deficiency in the accounts at that time the companies provide the money necessary to make up any deficit, and if there is a balance to the credit of the fund it is placed in the surplus account for the benefit of the members.

This explains the condition that while the companies have paid, for various periods, deficiencies amounting to $586,629.80, there have been in other periods amounts accumulated in excess of the liabilities, which, with interest thereon, paid by the companies at the rate of four per cent. per annum on monthly balances, amounts to $751,256.25.

While a portion of this surplus is due to interest received on the amount accumulated, still the amount of cash paid by the Companies, including $586,629.80, for the deficiencies that occurred at the close of periods of three years, when settlement of accounts between the Companies and the Fund occurred, shows conclusively that if it were not for the Companies' contributions, instead of the balance to the credit of the Fund there would be a large deficit.

It is well to note in this connection that every dollar contributed by its members is returned to them in benefits and that every cent of expense for conducting the Department, of any character whatever, is paid for by the Companies.

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It is, therefore, evident that the superannuation allowances that are paid are really made from money contributed by the Companies. In this connection it is pertinent to state that the "Superannuation allowances" and "Pensions" are two separate and distinct features. The Pensions are paid by the several Companies as gratuities to the employees retired from active service, without regard to whether they are members of the Relief Fund or not. The Superannuation allowances are paid in addition to the Pensions to the members of the Relief Fund who are retired from service, from the interest on the Surplus set aside for that purpose.

The policy of the companies is to treat liberally employees who have any proper grievance against them for injuries accidentally received, and consequently the litigation where liability actually exists is comparatively light, the large majority of the suits instituted being of a speculative character; that is to say, the plaintiff has really no valid claim, but is desirous of having the case tried in court, hoping that by some fortunate chance he may obtain a verdict in his favor.

At the hearings before the Judiciary Committee of the House of Representatives it was stated that while the name "Voluntary" was applied to the Pennsylvania Railroad Voluntary Relief Department, it was in fact compulsory, as the employees were virtually compelled to join the Relief Fund; in contradiction of this it may be stated that of the 125,383 employees on the Lines East of Pittsburgh and Erie on December 31, 1905, only 92,192 were members of the Relief Fund, and a large number of these were "new" employees, showing conclusively that it is not compulsory.

A further evidence of its voluntary character is shown in the liberty of members to withdraw from membership without loss of employment. As an illustration, it is found that from January 1, 1905, to April 1, 1906, there have been but 45 members who withdrew from the Relief Fund and only two of this number have left the service. This proportion is also true of other years.

Another illustration of the fact that membership is voluntary is forcibly shown by the average class held by the members. The statistics for the year 1905 indicate the average num-

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ber of classes held by each member to be two, and as members are privileged to take one class only, if they so desire, and as the second class is the limit that the average pay of the employees would permit, the higher class held is a clear indication that the members joined the Fund of their own free will and not by compulsion as alleged.

That the Relief Fund is not popular among the employees generally cannot be successfully maintained; its popularity is evidenced by the large membership, the average class held by the members, and the small number of withdrawals from the Relief Fund.

The Department has also been criticised for not permitting members after leaving the service to continue their membership. When the Department was first organized it was provided that all who entered the service after that date should become members of the Relief Fund, and owing to the provisions then in force it was also provided that membership could be continued after leaving the service, but, owing to objections of some of the employees, the compulsory feature was removed and with it the provision permitting a member to continue his death benefit after leaving the service, as it was not entirely clear that under the voluntary plan the corporate powers of the Companies would justify a guarantee by the Companies for the benefit of persons not in their employ.

It is true that numerous employees, members of the Relief Funds, have appeared before committees of state legislatures in defense of their rights as members of these Funds, and they should not be deprived of their just rights and privileges without proper hearing, as they have property interests that they should not be summarily deprived of. It is, therefore, manifestly unfair to deprive one class of employees from membership in organizations that inspire confidence and are most advantageous, and compel them to seek protection that is less reliable and more expensive in other organizations that may also be objectionable in other ways.

To maintain relief departments under the conditions imposed by the "Bates Bill" would seem to be impossible, as the Companies would be contributing to, and aiding to raise, funds that would in a number of cases provoke speculative suits, as

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the payment of benefits would provide the funds, and suit could be brought in every case of injury, whether liability on the part of the company did or did not exist.

It has been the aim of the management of the Companies to co-operate with representatives of the members to make the conditions affecting membership more attractive. This is evident in all the changes that have been made in the regulations since the operations of the Department began.

F. 8-B. A.

PHILADELPHIA ELECTRIC BENEFICIAL ASSOCIATION.

CERTIFICATE OF MEMBERSHIP.

No._____

OFFICE OF THE SUPERINTENDENT.

Philadelphia, Pa.,..... 190

THIS CERTIFIES, *That*.....

employed by the PHILADELPHIA ELECTRIC COMPANY, is a member of the

PHILADELPHIA ELECTRIC BENEFICIAL ASSOCIATION,

and is entitled to the benefits provided by the Regulations of the said Association (which Regulations are hereto annexed and which, together with any other Regulations of the said Association that may hereafter be adopted as herein provided are hereby made a part of this Certificate).

.....

Supt. of the Philadelphia Electric Beneficial Association.

PHILADELPHIA ELECTRIC BENEFICIAL ASSOCIATION.

IMPORTANT NOTICE.

Should you become sick or injured, notify at once your time-keeper or the officer under whom you are employed, giving date the disability began and your exact residence, and if not able to personally notify him, send a letter or postal card. (See Regulations.)

You are expected, when disabled and not confined to the house, to visit, at once, the Medical Examiner at his office, during office hours, and continue to report to him, in person, at such other times as he may request.

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The Medical Examiner is not expected to call upon you if you are able to go to his office, and are not prevented by distance. Do not change your residence during disability without notifying the Medical Examiner.

Special attention is called to the fact that when a member of the Association marries, and desires to make his Death Benefit payable to his wife, he must make an application in the prescribed form for the desired change; otherwise, in case of his death, the Benefit must be paid by the Association to the beneficiary, if living, previously designated by the member to receive it.

The above instructions should be closely followed.

H. C. LUCAS,
Superintendent.

EXHIBIT "C."

REGULATIONS GOVERNING THE PHILADELPHIA ELECTRIC BENEFICIAL ASSOCIATION.

(Taking Effect June 1st, 1907.)

ARTICLE I.

NAME.

The Association shall be known as the Philadelphia Electric Beneficial Association.

ARTICLE II.

OBJECT.

The object of the Association is the establishment and management of a fund to be known as the Benefit Fund, for the payment of definite amounts to the members of the Association, when under the regulations thereof, they shall be entitled thereto by reason of disability from accident, sickness or other cause, and, in the event of their death, to their relatives or other beneficiaries specified in their application or thereafter designated in accordance with said regulations.

ARTICLE III.

MEMBERS.

SECTION 1. Only employees of the Philadelphia Electric Company and its successors, or of its or their affiliated, con-

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trolled or leased Companies, shall be eligible to membership in the Association, and any member shall forfeit his membership and all benefits appertaining thereto upon leaving or being discharged from the service of his employer.

SECTION 2. Such employees desiring to become members of the Association shall sign an application in the form prescribed in Section 3 of this Article, and present the same to the Superintendent of the Association, who shall, if he approves thereof, issue a certificate of membership to the applicant.

SECTION 3. Application for membership in the Association shall be in the following form:

PHILADELPHIA ELECTRIC BENEFICIAL ASSOCIATION.

APPLICATION FOR MEMBERSHIP.

To the Superintendent of the Philadelphia Electric Beneficial Association:

I, ..., of ....., in the county of.....and State of..... ....., employed or about to be employed in the service of ..... Company, do hereby apply for membership in the Philadelphia Electric Beneficial Association, and consent and agree to be bound by the regulations of said Association, which I have read or which has been read to me, as contained in the book of said regulations, and by any amendment or amendments thereof or other regulations of said Association that may hereafter be adopted.

I also agree, that the said Company, my employer, or, any other Company whose employees may become members of the Association and which may hereafter employ me, shall by its or their proper agents, and in the manner provided in said regulations, apply as a voluntary contribution from any wages earned by me under such employment, or from benefits that may hereafter become payable to me, at the rate of..... ($.....) for the purpose of securing the benefits provided for in the said regulations of the said Association. Unless I shall otherwise designate, in the prescribed form, with the approval of the Superintendent of the Association, death

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benefit shall be payable to .....

.....

.....

And if any person now or hereafter designated by me to receive the death benefit shall not be living at the time of my death, or shall be incapacitated for executing the requisite receipt and release, or if there shall be no such person, the death benefit shall be payable to my heirs under the intestate laws of Pennsylvania, without liability for my debts. Any funeral or other expenses incident to my death which shall have been paid by the Superintendent of the Association, in accordance with the said regulations, shall be held to be in part payment of the said death benefit, and the amount so paid shall be deducted from the total amount of said death benefit before payment to the person or persons entitled to receive the same. And in consideration of the contribution to be made to the Beneficial Fund of the Association by the Philadelphia Electric Company, and its successors, I hereby agree that the acceptance of benefits from the said Association, for injury or death, shall operate as a release of all claims for damages against said Company, my employer, and against any of said affiliated, controlled or leased Companies by which I may hereafter be employed, arising from such injury or death, which could be made by or through me, and that I or my legal representatives will execute, or, where necessary, procure to be executed, such further instrument as may be necessary formally to evidence such acquittance.

I also agree, that this application, when approved by the Superintendent of said Association, shall make me a member of said Association on and from the date upon which, by the provisions of the regulations of said Association and the terms of this application, it takes effect, and shall constitute a contract between myself and the said Company, my employer, and such of the said affiliated, controlled or leased Companies by which I may be employed, and that the terms of this application and the regulations of said Association shall, during my membership, be a part of the conditions of my employment by said Company or Companies, or any of them, and that the same shall not be avoided by any change in the character of my service, or locality where rendered, while in such employment,

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or by any change in the amount applicable from my wages to the Beneficial Fund, which I may hereafter consent to, and that the agreement that the above-named amounts shall be appropriated from my wages shall apply also to any other amounts arising from changes made as aforesaid, and shall constitute an appropriation and assignment in advance to the said Company or Companies, my employers, in trust, for the purposes of said Association, of such portion of my wages, which assignment shall have precedence over any other assignment by me of my wages, or of any claim upon them, on account of liabilities incurred by me.

I also agree, for myself, and those claiming through me, to be especially bound by the regulations providing for final and conclusive settlement of all disputes by reference to the Superintendent of said Association, subject to appeal from his decision to the Board of Trustees.

I certify that I am correct and temperate in my habits; that so far as I am aware, I have no injury or disease, constitutional or otherwise, which will tend to shorten my life, and am now in good health and able to earn a livelihood.

I do hereby further acknowledge, consent and agree that any untrue or fraudulent statement made by me to the Medical Examiner, or any other concealment of facts in this application, or my resignation from the service of said Company, my employer, or from any of the said affiliated, controlled or leased Companies, or my being relieved from employment and pay therein at the pleasure of the said Companies, or any of them, or their proper officers, shall, except as otherwise provided in the regulations, forfeit my membership in the said Association, and all benefits, rights and equities arising therefrom, excepting that my leaving the service shall not, in the absence of any of the other foregoing causes of forfeiture, deprive me of any benefits to the payment of which I shall have previously become entitled by reason of accident or sickness occurring while in the service, as provided in said regulations.

This application shall take effect on the.....day of ....., A. D., 19 , if, on that date, I shall be on duty in the service of the said Company; otherwise, upon

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the date of my going on duty in such service, and am not at the time suffering from injury or disease.

In witness whereof, I have signed these presents at..... ....., in the county of..... State of ..... this ..... day of ..... A. D., 190.....

Witness .....

The foregoing application is hereby approved this day of ..... 190.....

.....

Superintendent of the Philadelphia Electric Beneficial Association.

SECTION 4. An application for membership shall take effect on the date specified therein, except as to one not on duty in the service of the Philadelphia Electric Company, or one or more of its affiliated, controlled or leased Companies, in which case it shall take effect at any subsequent date upon which the applicant goes on duty and is not at the time suffering from injury or disease. If the specified date be a Sunday or a legal holiday, on which the applicant is not on duty, the application shall nevertheless take effect on that date, if, by being on duty the working day immediately before and after such date, he shall be shown not to be disabled on that date.

SECTION 5. In any case in which notice in writing of the existence of heirs of such deceased member under the intestate laws of Pennsylvania shall not be served on the Superintendent of the Association within twelve months after such member's death, it shall be treated as conclusive that there are no such heirs in existence, and thereupon the said benefit shall lapse and become absolutely extinguished, and the amount thereof shall remain as part of the Beneficial Fund of the Association; but so much thereof as may be requisite for the necessary funeral expenses and proper expenses incident to the disability and death of the member shall in such case be paid from the Beneficial Fund.

SECTION 6. The designation of a person to receive the death benefit in trust for a minor child shall be presumed to

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last only during the minority, unless otherwise provided in the designation.

SECTION 7. Unless otherwise directed by the Superintendent of the Association, an application of a married woman must be signed also by her husband; and that of a minor by the father or other legal guardian.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of the Association shall be a Superintendent, a Treasurer and a Secretary, who shall be appointed annually by the President of the Philadelphia Electric Company, and its successors, or of its or their affiliated, controlled or leased Companies, in the first week of April. There shall also be a Board of eight Trustees, employees of the Philadelphia Electric Companies, and its successors, or of its or their affiliated, controlled or leased Companies, who shall be chosen by ballot at the Annual Meeting of the Association. The votes for the eight Trustees shall be counted and the result determined by tellers selected by the Board of Trustees. The officers of the Association shall be ex-officio members of the Board of Trustees. The members of the Board of Trustees to serve during the first year shall be chosen by the President of the Philadelphia Electric Company, and its successors, or of its or their affiliated, controlled or leased Companies, and members to fill vacancies thereafter occurring shall be designated by the Superintendent of the Association; such members shall serve until their successors are duly chosen as above provided.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. The Superintendent shall be the executive head of the Association and have general charge of all the business pertaining thereto. He shall preside at all the meetings of the Trustees, prescribe the forms and blanks to be used and the reports to be made to the Association, certify to the correctness of all bills and check rolls for employees of the Association and send them for approval to the Treasurer of the Association, and shall furnish to the Board of Trustees such reports as they may require.

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SECTION 2. Treasurer.—It shall be the duty of the Treasurer to collect all fees and dues from the members, through their attorney, i. e., the Treasurer of the Philadelphia Electric Company, or its successors, and to hold or invest the funds of the Association under the direction of the Trustees. He shall pay orders for money when drawn, as hereinafter provided. He shall make a monthly report of the financial affairs of the Association to the Trustees. He shall give good and sufficient bond with such surety and in such sums as shall be approved by the Superintendent of the Association.

SECTION 3. Secretary.—It shall be the duty of the Secretary to keep full and accurate minutes of the Association. He shall also perform such other clerical work as the Superintendent may direct.

SECTION 4. The Board of Trustees shall have general supervision of the operation of the Association, and shall see that they are conducted in accordance with the regulations. The Board of Trustees shall hold stated meetings once in every month at such time and place as they shall determine, and shall meet at other times at the call of the Superintendent.

SECTION 5. There shall be a Medical Examiner who shall act as the adviser of the Superintendent with respect to medical matters, and shall decide as to the character of the disability of members and their fitness for duty. The Medical Examiner shall make the required physical examination and prepare applications for membership in the Association, ascertain and report upon the conditions of members reported sick or injured and perform such other duties as may be required of him.

The expenses incurred by the Medical Examiner in the conduct of his work as Medical Examiner shall be borne by the Beneficial Association.

ARTICLE VI.

FEES AND DUES.

SECTION 1. Each member of the Association shall pay an entrance fee of One Dollar ($1.00). Each member whose monthly salary or wages shall amount to $150.00 or more, shall

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pay the sum of 75 cents as semi-monthly dues, and each member whose monthly salary or wages shall be less than $150.00 shall pay semi-monthly dues equivalent to one-half of one per cent. of his monthly salary or wages. The said dues shall be exacted semi-monthly in full from every member of the Association for any portion of the month while in the employ of the Company. Fees and dues shall be deducted from the member's wages on the pay-roll of the current half month and placed to the credit of the Association. When a member has no wages on the pay-roll his dues shall be deducted from his benefits if entitled to them, or from his wages of succeeding half month if absent with leave. All moneys deducted or retained from the wages of members of the Association by the Treasurer of the Philadelphia Electric Company, or its successors, shall be delivered semi-monthly to the Treasurer of the Association.

SECTION 2. The Philadelphia Electric Company, or its successors, and its or their affiliated, controlled or leased Companies, will assume all the expense of clerk hire, office room, and all charges for stationery, etc., and shall facilitate in every way, without any charge therefor, the investment and handling of the relief funds, from time to time, for the benefit of the Association, and shall further contribute to the said fund to the extent of a sum equal to the amount from time to time contributed by the employees, members of the Association, until the total sum contributed by the employees, members of the Association, and the Philadelphia Electric Company, or its successors, and its or their affiliated, controlled or leased Companies, shall aggregate the sum of $25,000, after which time the Philadelphia Electric Company, or its successors, or its or their affiliated, controlled or leased Companies, shall contribute a sum equal to fifty per cent. of the amount contributed by its employees, members of the Association, until such accumulated fund of the Association shall amount to $50,000, the sum to be contributed by the Philadelphia Electric Company or its successors, and its or their affiliated, controlled or leased Companies, shall be an amount equal to ten per cent. of the sum contributed by the employees, members of the Association, until such time as the accumulated fund shall amount to the sum of

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$100,000, after which time the Philadelphia Electric Company, or its successors, and its or their affiliated, controlled or leased Companies, shall make no further contribution, except at such time as the fund shall fall below $100,000, during which the Philadelphia Electric Company, or its successors, and its or their affiliated, controlled or leased Companies, shall contribute in the proportions, and under the conditions above set forth, until the said fund again reaches the amount of $100,000.

SECTION 3. Any member losing his right of membership in consequence of leaving or being discharged from the service of the Philadelphia Electric Company, or its successors, or its or their affiliated, controlled or leased Companies, may, if reinstated in same service, again become a member of the Association upon filing a new application as required in Article I, Section 3.

SECTION 4. Any member of the Association losing his rights of membership in consequence of leaving or being discharged from the service of the Philadelphia Electric Company, or its successors, or of its or their affiliated, controlled or leased Companies, without having drawn any benefits from the Association, within thirty calendar days after the date of his employment, shall be entitled to have returned to him the sum of $1.00 paid as entrance fee at the time of joining the Association, which sum he must again pay into the Association as an entrance fee at any future time he may again be employed by the Company. If, however, any member loses his right of membership in consequence of leaving or being discharged at a date later than 30 calendar days after the date of his employment, his entrance fee to the Association of $1.00 will not be returned to him; but in this case if at any future time he is again employed by the Company, and becomes a member of the Association he will not be obliged to pay an entrance fee.

ARTICLE VII.

BENEFITS.

SECTION 1. Sick Benefits.—The benefits awarded each member of the Association during sickness, other than that resulting from accident, shall amount to a sum equal to one-half of his regular wages, for a period not exceeding ten (10)

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weeks. Sick benefits will not be paid for a less period than one (1) full week, but will be paid for fractional parts of any week exceeeding that period.

SECTION 2. Accident Benefits.—The benefits awarded each member of the Association in case of accident shall amount to a sum equal to the full amount of his regular wages, and for a period not exceeding ten weeks, except in cases of serious injury, in which case the period of benefits may be extended by a vote of a majority of Trustees present at regular meeting. In computing accident benefits, the time of disability shall be taken as commencing upon the first day of disability upon which no wages are paid.

SECTION 3. In the event of any member of the Association in good standing becoming permanently disabled by reason of accident received while in the service of the Company, the Trustees shall, in pursuance of a resolution adopted by the unanimous vote of all the Trustees, at a regular meeting of the Board, draw an order upon the Treasurer of the Association for a sum not exceeding the aggregate yearly wages of such member, said sum to be paid to such member as soon after disability as practicable. In the event of the death of any member of the Association by reason of sickness or accident happening while a member of the Association, the Treasurer of the Philadelphia Electric Company, or its successors, or of its or their affiliated, controlled or leased Companies, shall at the request of the Trustees made through the Superintendent, deduct 50 cents from the wages of each member of the Association and pay the same to the Treasurer of the Association, who shall in turn pay the same as soon as practicable to the beneficiary or beneficiaries named, or as otherwise directed in the application of such deceased member; provided that if at any time the assessment of 50 cents per member shall amount to a sum exceeding $500.00, the assessment per capita shall be reduced proportionately so that the total amount collected by any one assessment shall not exceed $500.00. And the Philadelphia Electric Company, or its successors, shall contribute and cause to be paid to such beneficiary or beneficiaries, or as directed in the application of such deceased member, a sum equal to one-half the aggregate amount deducted from wages of members

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of the Association and paid over to such beneficiary or beneficiaries, as above provided. In case of the death of a member of the Association, after having been an employee of the Philadelphia Electric Company, or its successors, or of its or their affiliated, controlled or leased Companies, for five consecutive years, a sum of $250.00 shall be paid by the Treasurer of the Association, in addition to the death assessment and the contribution by the Philadelphia Electric Company, or its successors, or of its or their affiliated, controlled or leased Companies, to the beneficiary or beneficiaries, named upon the deceased member's application of membership.

SECTION 4. Members may at any time or times, by writing filed under their hands and seals, revoke the designation of beneficiaries named in the application during the life time of such beneficiaries, and appoint new beneficiaries, and they may appoint new beneficiaries from time to time, in which event or events the benefits herein declared to be payable to the beneficiaries named upon deceased member's application shall be payable to the persons designated in the new application in force upon the death of the respective members; but no revocation of a prior appointment, and no new appointment shall be operative or effective unless the same is in writing under the hand and seal of the member, witnessed by two persons and assented to by the Superintendent of the Association and the same lodged with the Association.

SECTION 5. The moneys which shall become due and payable under the provisions of these regulations shall be payable only to the member himself, or to his nominee in case of death, and same shall not be subject to or affected by any attachment or execution process whatsoever against such disabled member or his nominee.

SECTION 6. All orders drawn for benefits must be approved by a majority of the Trustees and signed by the Secretary and Superintendent of the Association.

SECTION 7. Benefits shall not be payable, both for accident and sickness, at the same time.

SECTION 8. Benefits on account of disability will be paid semi-monthly.

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SECTION 9. Claims for death benefits will be payable within thirty days after the required evidence is furnished of their validity.

SECTION 10. A part of the death benefit may be paid before the final settlement to meet funeral or other urgent expenses incident to the death and preceding disability of a member, same to be deducted from the total amount upon final payment; provided any such payment, without the written authority of the person or persons to whom the death benefit is payable, shall not exceed the sum of $125.00. If, however, any of the persons to whom the death benefit is payable are incompetent, or cannot be found, or are in a foreign country, or such persons are dead, the Superintendent of the Association may make such payment as a part of the death benefits as in his judgment may be reasonable for the proper burial of the deceased member and the payment of expenses necessarily incident to his death and disability immediately preceding.

SECTION 11. Benefits payable on account of disability of a member by accident or sickness shall be paid only to the disabled member. Such benefits, however, payable to a member unable to execute a proper receipt, whether because of insanity or other incapacity, may, in the absence of a legally appointed representative, be paid to the wife or family or some relative or other proper person selected by the Superintendent of the Association to be used for the benefit of the members of his family, and the receipt of such a person shall be a sufficient discharge.

SECTION 12. Disability benefits remaining unpaid at the time of the death of a member shall be payable to the person or persons entitled to receive the death benefits.

ARTICLE VIII.

MISCELLANEOUS.

SECTION 1. Should a member or his legal representative, or any other person authorized by law bring suit against the Philadelphia Electric Company, or its successors, or any of its or their affiliated, controlled or leased Companies, for damages on account of injuries or death of such member, payment of benefits from the Beneficial Fund on account of same shall not

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be made until such suit is discontinued. If prosecuted to judgment or compromise, and payment of judgment or amount in compromise shall preclude any claim upon the Association for such injury or death.

SECTION 2. A member who shall be absent from duty on account of sickness or injury must at once notify the head of the Department in which he is employed, or the foreman who keeps record of his time, and he will not be entitled to benefits for time previous to such notice, unless the delay shall have been unavoidable, and the reason stated in writing.

SECTION 3. A member must keep his foreman or time-keeper informed of his address and of any change of the same.

SECTION 4. A member who fails to return to duty on account of continued disability, upon the expiration of the period for which disablement benefits are paid, will be considered as absent on furlough.

If a member while on furlough fails to contribute for three consecutive months, and does not resume contributions at or before the expiration of that time, his membership shall cease.

A member on furlough may contribute his regular dues and assessments for nine consecutive months, and if at the expiration of that time he shall not have returned to duty, his membership shall cease.

SECTION 5. The responsibility of the Association to any member shall end when he ceases to be employed by the Philadelphia Electric Company, or its successors, and of its or their affiliated, controlled or leased Companies, except for benefits to the payment of which he shall have become previously entitled by reason of accident or sickness occurring while in the service of the Company.

SECTION 6. When a member leaves the service he must surrender his Certificate of Membership and Book of Regulations to the person from whom he received his final payment in wages, unless some satisfactory explanation in writing is given for not doing so.

SECTION 7. All questions, disputes or controversies of whatsoever character arising in any manner or between any parties or persons in connection with the Association or the

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operation thereof, whether as to the construction or meaning of the Regulations, Applications for Membership, or as to any paper, writing, decision, instruction or acts in connection with the Association, shall be submitted to the Superintendent of the Association whose decision shall be final and conclusive thereon, subject to the right of appeal to the Board of Trustees within thirty days after written notice of the decision to the parties interested therein.

SECTION 8. The fiscal year of the Association shall begin with the first day of January in each year.

SECTION 9. The condition of the Relief Fund at the close of each fiscal year shall be audited and reported by a competent person or persons selected for that purpose by the members of the Board of Trustees.

SECTION 10. The Annual Meeting of the Association for the election of Trustees and the reading of the reports of the Association for the fiscal year, shall be held on the first Thursday in April.

ARTICLE IX.

AMENDMENTS.

SECTION 1. Amendments to or changes in these regulations may be proposed by the Board of Trustees, but they shall not be operative unless presented at a stated meeting of the Board and considered and adopted at a subsequent meeting by a majority of the whole Board; and such amendments and changes so adopted, written notice whereof shall have been enclosed in the pay or benefit envelope of each member or mailed to each member at his address as registered on the books of the Association, shall be binding upon the members of the Association from the dates fixed in the resolution approving the same.

EXHIBIT "D."

UNITED TRACTION AND ELECTRIC COMPANY

With: *Contract.*

UNITED TRACTION EMPLOYEES' MUTUAL AID ASSOCIATION.

WHEREAS, An Association has been organized under the name of the United Traction Employees' Mutual Aid Association by employees of the United Traction and Electric Com-

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pany and of various companies owned, operated or controlled by it, and

WHEREAS, The purposes and objects of said Association are, as more fully set forth in its Constitution and By-Laws (to which reference is hereby made), to furnish benefits during the disability of its members and benefits to dependents upon the death of a member, and

WHEREAS, The United Traction and Electric Company is desirous of aiding in the accomplishment of the purposes and objects of said Association and of co-operating with said Association in securing to its members and the several companies by which they are employed, the mutual advantages to be derived from such an Association, and of providing, in this manner, an additional inducement and compensation to the employees of said companies for faithful and meritorious service, and

WHEREAS, The said Association is desirous of such aid and co-operation of the United Traction and Electric Company.

Now, therefore, this Agreement, made this 19th day of October, A. D., 1901, by and between the said United Traction and Electric Company (hereinafter called "the Traction Company") and the said United Traction Employees' Mutual Aid Association (hereinafter called "the Association").

WITNESSETH:

First.—The Association agrees that its management shall always be vested in a board of seven trustees, four of whom shall be chosen by the directors of the Traction Company; and that the contributions collected from members, and the payments made to members or other beneficiaries for death or disability benefits shall be such and shall be made upon such terms and conditions as are prescribed by the By-Laws of said Association now in force (a copy of which, marked "Exhibit A," is hereto annexed and made a part hereof) and any amendments thereof adopted in the manner therein provided; and that the proceedings and government of said Association shall be in conformity with said By-Laws and amendments.

Second.—The Traction Company agrees to contribute to the funds of the Association as follows, *viz.*:

(1) One hundred (100) of each five hundred (500) dollars payable at the death of a member of the first class; one

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hundred and fifty (150) dollars of each seven hundred and fifty (750) dollars payable at the death of a member of the second class; and two hundred (200) dollars of each one thousand (1,000) dollars payable at the death of a member of the third class.

(2) One-fourth of the amount of contributions by the members, payable weekly as the said amount may be determined.

(3) Sums from time to time, sufficient to meet the current expenses of management, including expenses of adjusting and litigating claims, and

(4) Sums equal to the deficiencies which may at any time be found to exist in the funds of the said Association; provided that contributions to make good any such deficiencies shall be repaid out of any surplus of such funds as may thereafter be accumulated.

Third.—The Traction Company further agrees to make collection of the contributions of the members of the Association by deducting or causing to be deducted from their wages, pensions of disability benefits as the case may be, the amount of such contributions, as fixed by the By-Laws of the Association; and to turn over, or cause to be turned over to the Association the full proceeds of such collection without deduction or charge.

Fourth.—This agreement shall remain in full force and effect until all obligations for benefits assumed by the Association in accordance with its By-Laws are discharged; provided, however, that modifications may be made at any time and from time to time, if approved by all the trustees of the Association and a majority of the directors of the Traction Company.

IN WITNESS WHEREOF, the said United Traction and Electric Company has caused its name to be hereto subscribed and its seal to be hereto affixed, by Marsden J. Perry, its Vice-President, thereunto duly authorized, the day and year first above written; and in like witness said United Traction Employees' Mutual Aid Association has, on the same day, caused its name

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to be hereto subscribed and its seal to be hereto affixed by Cornelius S. Sweetland, its Treasurer, thereunto duly authorized.

UNITED TRACTION AND ELECTRIC COMPANY,
By MARSDEN J. PERRY,
Vice-President. [SEAL.]

UNITED TRACTION EMPLOYEES' MUTUAL AID ASSOCIATION,
By CORNELIUS S. SWEETLAND,
Treasurer. [SEAL.]

In presence of:
WALTER F. ANGELL.

OFFICE OF THE MILWAUKEE GAS LIGHT COMPANY.

Milwaukee, Wis., Dec. 23, 1899.

To the Employees of The Milwaukee Gas Light Co.:

This Company proposes for the present to adopt a system of profit sharing with its employees, by which those regularly and continuously employed will share in the prosperity of the Company.

Such employees as are regularly and continuously employed by the Company will receive in January and July of each year a percentage bonus on the wages earned by them during the previous six months, equal to the annual percentage dividend which is paid to the stockholders of the Western Gas Company. Thus, as dividends to stockholders are increased or decreased, this percentage on the wages of employees will be increased or decreased in the same proportion.

All employees regularly and continuously employed by the company for one year, shall, after such period be entitled to receive this bonus; but no bonus will be paid upon wages earned during the first year's service.

Regular employees are those who during each six months' period, ending June 30th and December 31st of each year, shall have earned not less than one-half a full month's wages each month and not less than a total of five full months' wages for the six months' period.

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Dividends upon the stock of the Company are now paid at the rate of six per cent. per annum.

Every regular employee in the service of the Company January 1st, 1900, having met the conditions herein stated for the last six months of 1899, and who shall have been regularly and continuously employed for one year previous to July 1st, 1899, will, on or about January 20th, next, receive the first payment under this proposition, amounting to six per cent. on the amount of wages earned during the last half of the year 1899.

This system does not apply to elective officers of the Company.

Yours truly,

E. G. COWDERY,
General Manager.

OFFICE OF
THE NEW HAVEN GAS LIGHT COMPANY,
NEW HAVEN, CONN.

January 21, 1907.

To the Employees of The New Haven Gas Light Company:

The Plan for Profit-Sharing enclosed herewith was adopted by the Directors of the Company on January 15, 1907.

The Plan applies to all employees who have worked continuously for the Company during the entire year of 1906.

To insure prompt application of the Plan to all who are not now, but who may become entitled to it, each employee is requested to notify the Company when he has been employed for one continuous year.

The Directors hope this plan will be accepted by the employees in the spirit in which it is offered as quite fully expressed in the book enclosed.

For the Directors:
CHARLES H. NETTLETON, *President.*

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PLAN FOR PROFIT-SHARING WITH THE EMPLOYEES,

Adopted by The Board of Directors

OF

THE NEW HAVEN GAS LIGHT COMPANY,

January 15, 1907.

This plan shall apply to all employees of The New Haven Gas Light Company, except the executive officers, provided they shall have been continuously employed by the Company for one year.

Commencing on the first of April, 1907, there shall be credited quarterly to every such employee eight per cent. (8 per cent) on the wages received for the preceding three months which is the same rate at which dividends are now paid annually to the stockholders. On April 1st, July 1st, October 1st, and January 1st, in each year, if the amount credited to any employee is equal to the then market value of one or more shares of the stock of this Company, then immediately a Certificate representing one or more shares, shall be transferred to such employee, to become his property absolutely, to keep or sell, as he may elect, and the balance, if any shall be carried forward into the next quarter.

This plan is subject to the following restrictions:

1. If a man, for any cause, is unable to allow this credit to increase until he can have one share of stock, but wishes to withdraw the amount in cash, on any of such quarter days, he shall receive only one-half of the amount of the credit.

2. If an employee be discharged for any cause, except drunkenness, insubordination, commission of some crime, or destruction of the Company's property, he shall receive his balance in full, but if discharged for these causes, or any of them, he shall forfeit the entire balance.

3. If an employee leave the Company, on his or her own volition, one-half of the amount of the credit shall be paid in cash, except in the case of a woman leaving the Company on the occasion of her marriage, in which event the Company shall pay the full amount of the balance. In case of the death of

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any employee the balance shall be paid to his legal representative in full.

4. The acceptance of this plan shall not be obligatory, but before an employee shall be entitled to receive the benefits of the plan, he shall sign an agreement embodying the terms hereof.

5. The Directors reserve the right to refuse permission to sign an agreement to anyone who lacks interest in the welfare of the Company, or who is wasteful of the Company's property, or careless or negligent in the performance of his duties; or to cancel an agreement already signed on one week's notice to any employee, and the Directors reserve the right to amend these rules from time to time, and also to terminate the whole plan at any time by giving three months' notice of its intention.

6. No assignment of any sum credited will be recognized by the Company, nor shall any sum be deemed to be due to any employee at any other time, or in any other way than as herein provided.

By this plan the Directors hope to accomplish certain results:

1. That the employees of the Company will feel a greater interest in their work by reason of being directly interested in the Company.

2. That it will increase the income of the majority of the employees.

3. That it will tend in the direction of each employee saving a part of his wages.

4. That it will tend to increase the pleasure and satisfaction of working for the Company, particularly for those who remain with the Company for a number of years; that they will become both in theory and in fact a part of the Corporation through their ownership of its stock.

A similar plan to this has been in operation in England for sixteen years in one Gas Company, and for a shorter period in others, and with the most satisfactory success both to Corporation and Employees. In this country it has been tried for four years in one Gas Company, and within the past year has been adopted by a second.

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When the stock shall have been issued to the employees, the Company offers to keep it in a safe deposit box without charge, giving a receipt therefor, but it is entirely optional with the employee whether this be accepted or not.

The Company requests that in case of any employee selling his stock, he shall offer it first to the Company at the then market price, to be used again for the same purpose, but this also is not in any sense obligatory.

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PROFIT-SHARING PLAN OF GRAND RAPIDS GAS LIGHT COMPANY.

"Be it therefore Resolved: That for the purpose of rewarding continuous and faithful service on the part of the employees of this company, hereafter and until otherwise ordered by the Board of Directors, on any date when a semi-annual dividend is declared on the capital stock of this Company, there shall also be ordered paid to the employees of this Company additional compensation, except that such additional compensation shall not be paid to the President, Vice-President, Second Vice-President, Directors, Secretary, Treasurer, Assistant Secretary, Assistant Treasurer, or General Manager. The amount of additional compensation, to be paid to each employee, shall be determined by multiplying the total sum of each employee's wages or salary during the six calendar months preceding the first day of the month in which the dividend to stockholders is payable, by twice the decimal figures that are used in arriving at the amount of semi-annual dividend to be paid on the capital stock of the company. And be it further resolved, that to entitle any officer, agent or employee of the Grand Rapids Gas Light Company to receive and share in additional compensation for meritorious services, the following condition must obtain in every instance:

The employees must have been in the continuous employ of the Grand Rapids Gas Light Company for one year and six months preceding the last day of the half year for which extra compensation may be awarded."

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THE COLUMBUS RAILWAY & LIGHT COMPANY.

Synopsis of Profit-Sharing Plan Extended by the Management to Employees of The Columbus Railway & Light Company.

This consists of what is termed an Employees' Dividend, and is paid quarterly at the same time dividends are paid to stockholders of the Company, and in the same ratio, *viz.*:

The shares of the stockholder are an investment, and upon the preferred stock the Company is paying 5 per cent. annually, or, 1¼ per cent. quarterly; the same rate is also paid upon the common stock of the Company.

That of the employee is an earning instead of an investment, and the total amount earned for the quarter is the amount upon which he is entitled to a dividend. For example: A dividend of 5 per cent. is paid upon the Preferred Stock at quarterly periods, February 1st, May 1st, August 1st and November 1st, being 1¼ per cent. quarterly. Simultaneously with the above dates dividends to employees are paid in the same ratio for each quarter ending on those dates. The amount, due as dividend to employees, is based upon the amount earned for the quarter, which, we will say, is $100 per month, or $300 for the quarter = $1,200 per year. The quarterly $300, multiplied by 5 per cent. produces $15, and which amounts to the same as a twelve hundred dollar stock investment would, if divided into quarters of $300, each at 5 per cent. or $60 per year; the only difference being that the 5 per cent. dividend to employees is paid in full as earned, whereas the dividend to stockholders is divided up, for convenience, into quarterly periods of 1¼ per cent; in either case the result is the same. This procedure also applies to the Common Stock dividends paid quarterly, at the 5 per cent. rate, March 1st, June 1st, September 1st and December 1st; the two dividends together amounting to 10 per cent. per annum, and to employees a like per cent.

To participate in a dividend an employee must have been in the continuous service of the Company six months prior to the date on which a dividend is paid; that is, if a dividend is paid on August 1st, for the quarter ending July 31st, such employee

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is not entitled to participation unless practically full service has been given since February 1st.

Should an employee leave or be dismissed from the service of the Company during the quarter in which dividend is computed, he forfeits all claim and his account is ruled off the books of the Company.

The foregoing synopsis applies to stock issues of The Columbus Railway Company, now being operated under lease by The Columbus Railway & Light Company. The latter Company has a stock issue of its own, but no regular dividend paying dates have, as yet, been established. However, a dividend of 1 per cent. on this issue was paid January 15, and the same amount July 16, 1906, also January 15 and July 15, 1907, 1 per cent. each, in which employees participated in the same ratio, making altogether, for the two years, twelve per cent. on earnings per year.

UNITED STATES STEEL CORPORATION.

New York, December 31, 1902.

To the Stockholders of The United States Steel Corporation:

Gentlemen:—Enclosed you will find copy of a circular letter, this day issued to the employees of the United States Steel Corporation and its subsidiary companies.

This circular sets forth two plans by which it is hoped to accomplish the following objects, *viz.*:

First. To interest a large number of the employees of the Corporation and its subsidiary companies in becoming permanent stockholders.

Second. To engage on a profit-sharing basis the services of the presidents, officers, managers, superintendents and all others charged with responsibility in managing the affairs of the Corporation, thus making these men actual partners with you in the ownership and management of the Corporation.

At the time of the organization of the United States Steel Corporation, many of the subsidiary companies were managed, to a greater or less degree, by men who had a very large personal pecuniary interest in them, and naturally gave to the

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direction of the affairs of their companies a large part or all of their time.

The aim of the Steel Corporation has been to devise some plan by which to maintain this same important incentive, but in place of having it center in comparatively few men, so to distribute its effect throughout the Corporation that every man, in his place, would feel that he had become a partner in the business, and would work from that point of view.

A profit-sharing plan of some kind has seemed to be the only way of reaching this most desirable end, and since the Corporation was organized two years ago the Finance Committee has given much thought to the consideration of such a plan.

The plan, now announced, is one that has met with unanimous approval and it will be tried. After the test of use improvements can doubtless be suggested, and all such suggestions will be cordially welcomed and, if practicable, adopted.

One of the main purposes has been to devise some plan that with equal fairness would apply to every man, from the President of the Steel Corporation itself to the man with pick and shovel, working for one of the subsidiary companies.

In addition it was desired to accomplish the following objects:

1. To interest the large number of young and able employees in the work of more closely organizing and systematizing the business in all its branches and ramifications, not only in connection with their own local concerns, but as a integral part of the Steel Corporation as an harmonious whole.

2. To interest these men in reducing the general expenses as well as the particular cost of manufacture.

3. To offer to these men an inducement to remain permanently in the Corporation's service.

4. To avoid the tendency of a profit-sharing plan pertaining solely to a constituent company to build up the profits of that company to the possible detriment of the broadest and best interests of the Corporation as an harmonious whole, and therefore to base the plan on the profits of the Corporation itself.

5. To devise a plan by which, in the apportionment of money for the improvement and development of plants, Com-

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pany A, for instance, would be interested in what Company B was doing, and Company B in what Company A was doing, constituting, as nearly as possible, automatic regulation against unnecessary duplication of appropriations.

The Finance Committee realizes that the accomplishment of all the above desirable results will severely test any one plan, and the plan recommended may fall short of our expectations. It has, however, been canvassed very carefully with the presidents of all the subsidiary companies, and it has met with their unanimous approval.

It is believed that at the very beginning the plan will interest a substantial number of the most thrifty men, and that eventually it will interest many of them.

It will be noted from the enclosed circular that of the stock which is offered for sale the workingmen have been allowed to subscribe for a much larger amount than the officers can subscribe for. This is because at present it is impossible to devise a plan for sharing with the laboring men profits based on their daily wages; but it is believed that profits can be shared with these men based, so to speak, on stock held by them, and especially with such men as shall continue permanently in the Corporation's service. This plan will embrace a large body of men who have no part in the direct management of the Corporation's affairs, are not directly responsible for results, and are not able, in any direct way, to affect the cost of manufacture or the net profits as a whole, and yet who, by their faithful service, are able to contribute much to the general gain of the Corporation and should be recognized in some substantial manner.

In round figures, it requires $75,000,000 to pay the interest on the Corporation's bonds, dividends at the rate of 7 per cent. on its preferred stock, dividends at the rate of 4 per cent. on its common stock, and to make sinking fund deposits.

At this date there are about 55,000 stockholders. These stockholders, of course, own the vast properties of the United States Steel Corporation. It is believed that they and other possible investors in the Corporation's bonds and stocks would feel a special sense of security in the continued earning power of the Corporation if they knew that the officers and the manag-

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ing men generally of the entire organization were willing to enter into a contract by which part of their compensation for services rendered shall be paid only after the realization of $80,000,000 of profits; in other words, after interest on bonds, dividends on preferred and common stock, and sinking funds shall have been earned and paid or set aside.

It has been and still is intended, therefore, to make such an adjustment of salaries as shall seem proper in order that every man in the employ of the Corporation or of any of its subsidiary companies will feel that he is receiving a fair and reasonable compensation for his services, and that over and above such sum he shall have an opportunity each year to earn a substantial extra sum of money, provided he and his associates shall have been successful in earning for the stockholders a substantial surplus over and above interest, dividend and sinking fund charges. The basis of this is outlined in the accompanying circular.

In the matter of adjusting salaries, we have gone far enough to know that on and after January 1, 1903, we will have in the employ of the Steel Corporation and of all of its subsidiary companies not to exceed 12 men with salaries of $20,000 a year or over. This includes the salary of $100,000 which is fixed as belonging to the office of President of the Corporation itself. There will be not to exceed 50 men who will receive from $10,000 to $20,000 a year. There will be about 200 men who will receive from $5,000 to $10,000 a year, and something over 1,500 men who will receive from $2,500 to $5,000 a year.

We believe that the profit-sharing plan proposed in connection with the men receiving these salaries will materially quicken the interest of a large number of our men in the general success of the Steel Corporation, and that it will retain them permanently in its service; that it will stimulate individual effort all along the lines, giving us an increasingly solid and compact organization working for one common end, and enabling us to get general support for all plans promising further economies in manufacture and in administration. In this way more than in any other not already adopted can we provide a guaranty of the continued success of the Corporation.

An immediate, important, and far reaching result of thus

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welding together the men of all the subsidiary companies and of interesting them in working for one common object, is obtained through the following important arrangement for making appropriations for maintenance, alterations and extensions of plants during the year 1903.

In the past, if any subsidiary company desired an appropriation for any purpose, the president of the Company made his recommendation to the officers of the Steel Corporation, who investigated it fully and referred it to the Executive Committee, which considered the matter from every point of view, and, if approved, passed it on to the Finance Committee for final action.

Now, that we are to interest the presidents and the other officers of each subsidiary company in the profits of each of the other subsidiary companies, through a profit-sharing plan of the Steel Corporation as a whole, it will be found entirely practicable and highly advantageous to have the president of each subsidiary company give his opinion as to the advisability of a contemplated improvement or expenditure on any one of the plants, and to this end, regularly to call the presidents of the subsidiary companies together as a manufacturing committee for conference. At such conferences all questions of contemplated expenditures and improvements on any plant will be discussed by the presidents of all the companies, and their recommendations will then go to the officers of the Steel Corporation and to the Executive Committee and ultimately to the Finance Committee.

In the same way questions of purchasing supplies, and other questions of common interest, will be taken up at these President's meetings and will be dealt with from the broad point of view of the success of the Steel Corporation as a whole. In short, the idea, as far as possible, is to administer the interests of the Steel Corporation by committee work, and to impress on every one in authority, wherever possible and of advantage to the Corporation, as a whole, the importance of making such plant supplement, and co-operate with, every other plant of the United States Steel Corporation.

By order of the Finance Committee:

UNITED STATES STEEL CORPORATION,
GEORGE W. PERKINS,
Chairman.

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New York, December 31, 1902.

To the Officers and Employees of the United States Steel Corporation and of its Subsidiary Companies:

Gentlemen:—For several months the Finance Committee has been engaged in perfecting a plan which, in its opinion, would make it your common interest to become permanent holders of the preferred stock of the Corporation.

The Finance Committee has been endeavoring also to devise some comprehensive plan under which those of you who are charged with the responsibility of managing and directing the affairs of the Corporation, or of its several subsidiary companies, shall receive compensation partly on a profit-sharing basis.

The Committee has not been willing to adopt any system that shall not include every employee, from the President of the Corporation itself to the men working by the day in the several subsidiary companies.

A plan which, in the judgment of the Finance Committee, will accomplish these results, was submitted to the Board of Directors at its December meeting, and by unanimous vote the Finance Committee was authorized to proceed to perfect and to promulgate the plan. It is now submitted to you, in the hope and belief that it will receive from all of you the same hearty approval that was given to it by the Presidents of the several subsidiary companies, who were freely consulted while the plan was being thought out and put into shape.

The plan is divided into two parts.

Part One:

From the earnings of the Corporation, during the year 1902, there will have been set aside at least Two Million dollars, and as much more as is necessary, for the purchase of at least 25,000 shares of the Corporation's Preferred Stock for the purpose of making the following offer to all the employees of the Steel Corporation and of its subsidiary companies:

At the present time there are in the service of the Corporation, and of its subsidiary companies, about 168,000 employees, whom we propose now to divide into six classes, as follows:

Class A will include all those who receive salaries of $20,000 a year or over.

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Class B will include all those who receive salaries of from $10,000 to $20,000 a year.

Class C will include all those who receive salaries of from $5,000 to $10,000 a year.

Class D will include all those who receive salaries of from $2,500 to $5,000 a year.

Class E will include all those who receive salaries of from $800 to $2,500 a year.

Class F will include all those who receive salaries of $800 a year or less.

During the month of January, 1903, the above-mentioned stock will be offered to any and every man in the employ of the Corporation, or any of its subsidiary companies, at the price of $82.50 per share; subscriptions for this stock to be made on blanks obtainable at the office of the treasurer of any subsidiary company.

Every man can subscribe for as much stock as he chooses, not to exceed the sum represented by a certain percentage of his annual salary, as indicated in the following table:

Any man who belongs in class A, as indicated in the preceding classification, will be allowed to subscribe for an amount of stock represented by a sum not to exceed 5 per cent. of his annual salary.

Class B, 8 per cent.
Class C, 10 per cent.
Class D, 12 per cent.
Class E, 15 per cent.
Class F, 20 per cent.

If, on this basis of subscription, more than 25,000 shares shall be subscribed for, 25,000 shares will be awarded to the several subscribers in the order of the classes beginning with the lowest or Class F, the upper classes to receive only in case any stock shall remain untaken by the Class below, and each class to receive ratably in the amount left for that class if there be not enough to satisfy the full subscription of that class, but each subscriber will be allotted at least one full share, even though this might make it necessary for the Finance Committee to purchase more than 25,000 shares.

Payment of the subscriptions for the stock must be made in

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monthly instalments, to be deducted from the salary or wages of the subscriber, in such amounts as he may desire, not to exceed 25 per cent. of any one month's salary or wages.

A man may take as long as he chooses, not exceeding three years, to pay for his stock.

Dividends on the stock will go to the subscriber from the date on which he commences to make payments on account of his subscription.

Interest at 5 per cent. will be charged on deferred payments on the stock.

In case a man shall discontinue payments before his stock shall have been fully paid for, he can withdraw the money he has paid on account of principal and may keep the difference between the 5 per cent. interest he has paid and the 7 per cent. dividend he has received on the stock; and thereupon his subscription and all interest on the stock to which the same relates shall cease and determine.

As soon as the stock shall have been fully paid for, it will be issued in the name of the original subscriber and the certificate will be given to him, and he can then sell it any time he chooses. But as an inducement for him to keep it and to remain continuously in the employ of the Corporation or of one or another of the subsidiary companies, and to have the same interest in the business that a stockholder or working partner would have, the following offer is made, *viz.*:

If he will not sell or part with the stock, but will keep it and in January of each year, for five years, commencing with January, 1904, will exhibit the certificate to the Treasurer of his company, together with a letter from a proper official, to the effect that he has been continuously in the employ of the Corporation or of one or another of its subsidiary companies during the preceding year, and has shown a proper interest in its welfare and progress, he will during each of such five years receive checks at the rate of $5 a share per year. For example: If a man buys one share of this stock in January, 1903, he will undertake to pay $82.50 for it. If after paying for it he keeps it for five years he will, in each year, have received dividends at the rate of 7 per cent. on the par value of the stock, and also will have received each year an extra dividend, so to speak, of

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$5; this latter sum being paid him as special compensation for rendering continuous faithful service to the Corporation or to one or another of its subsidiary companies, as shown by the exhibition of his certificate together with a letter from a proper official showing that he has worked to promote the best interests of the company in which he has thus become practically a partner.

If he shall remain continuously in the service of the Corporation or of one or another of its subsidiary companies for five years, at the end of the fifth year the Corporation intends that he shall receive a still further dividend, which cannot now be ascertained or stated, but which will be derived from the following source, *viz.*:

All who subscribe for stock in January, 1903, and commence to pay for it, but who discontinue at any time during the five years, of course will not receive the $5 per share for such of the five years as remain after they discontinue. The corporation will, however, pay into a special fund each year the $5 payments that would have been made to such subscribers had they continued. This fund shall be credited with 5 per cent. annual interest, and at the end of the five years period the total amount thus accumulated will be divided into as many parts as shall be equal to the number of shares then remaining in the hands of men who shall have continued in such employ for the whole five years, and the Corporation will then, by its own final determination, award to each man whom it shall find deserving thereof, as many parts of such accumulated fund as shall be equal to the number of shares then held by him under this plan:

Provided, however, that if a subscriber shall have died or shall have become disabled while faithfully serving the Corporation or one or another of its subsidiary companies, during such five years' period, the money theretofore paid by him on account of the stock he was purchasing, or, if he has fully paid for it, the certificate of stock may be turned over by the Corporation to his estate or to him, together with a sum equal to $5 per share for each of the five years not then expired.

If this plan shall be received favorably and shall meet with success, it is intended at the close of next year, to make a similar

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offer, excepting, of course, that the price at which the stock then will be offered cannot be guaranteed now; it is, however, the intention to offer it at about the then market price, and in all other respects to make the terms of the offer similar to those now submitted.

The continuation of this policy would make it possible for a man to buy one or more shares of the stock each year under a contract with the Corporation upon terms offering a safer and more profitable investment than he could possibly find for his savings anywhere else.

Part Two:

During the year we have been and are now engaged in making changes and adjustments in the salaries of the men who occupy official and semi-official positions, and who are engaged in directing and managing the affairs of the Corporation and of its several subsidiary companies in all the various branches of the departments of mining, manufacturing and transportation.

We have been making these changes preparatory to inaugurating, on January 1, 1903, a plan by which all the men who are thus directly or indirectly charged with the responsibility of managing and operating these vast properties, will share with the stockholders in any profits made after a certain amount of annual net earnings shall have been reached, and to this end the following plan has been adopted:

In round figures it requires about $75,000,000 to pay the interest on the bonds of the Corporation and of its several subsidiary companies, the dividends on the preferred and common stock, at the rates now being declared, and to make sinking fund deposits.

The Board of Directors has approved the recommendation of the Finance Committee to the effect that

Whenever $80,000,000 and less than $90,000,000 is earned during 1903, 1 per cent. shall be set aside;

Whenever $90,000,000 and less than $100,000,000 is earned during 1903, 1.2 per cent. shall be set aside;

Whenever $100,000,000 and less than $110,000,000 is earned during 1903, 1.4 per cent. shall be set aside;

Whenever $110,000,000 and less than $120,000,000 is earned during 1903, 1.6 per cent. shall be set aside;

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Whenever $120,000,000 and less than $130,000,000 is earned during 1903, 1.8 per cent. shall be set aside;

Whenever $130,000,000 and less than $140,000,000 is earned during 1903, 2 per cent. shall be set aside;

Whenever $140,000,000 and less than $150,000,000 is earned during 1903, 2¼ per cent. shall be set aside;

Whenever $150,000,000 and less than $160,000,000 is earned during 1903, 2½ per cent. shall be set aside.

It is intended that not only the Presidents, Officers, Managers and Superintendents shall share in these profits, but they shall be shared in as well by all other men charged with responsibilty in managing the affairs of the Corporation, and the final selection of the men, who shall share, is to be made by the Finance Committee of the Steel Corporation.

The question of what constitutes profits and all other questions shall be determined solely and finally by the Finance Committee, and as this Committee will have no interest whatsoever, directly or indirectly, in the profit-sharing plan, its rulings must be accepted by all as fair, impartial and conclusive.

We may not, in the first year, get an equitable apportionment, but it is not the intention to make permanent the above schedule or the apportionment of the same. The programme is hereby announced as the plan for the year 1903, and the Finance Committee reserves the right to modify any apportionment that is made at the end of each quarter during the year, and reserves the right to announce this or any other plan as a substitute for this, at the end of 1903 for the year 1904.

Any profits distributed under the above schedule and to the above classes of men will be paid out as follows, for example: If $80,000,000 be earned during the year 1903, then $800,000 would be the sum set aside for distribution. It is proposed to distribute one-half of this sum in cash, quarterly, during the year; reserve the other half until the end of the year; and then invest it in preferred stock; divide the amount of stock thus purchased, distributing one-half to the employees who are entitled to it, and holding the other half in the hands of the treasurer of the Corporation, giving each man a certificate for his interest, the certificate to recite among other things:

First.—That if he remains continuously in the service of

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the Corporation or of one or another of its subsidiary companies for five years, the stock shall be delivered to him and he may do as he likes with it.

Second.—That if he dies or becomes totally and permanently disabled while in the employ of the Corporation or of one or another of its subsidiary companies, the stock will be delivered to his estate or to him.

Third.—That he can draw the dividends declared on the stock while it is held for his account and he remains in the employ of the Corporation or of one or another of its subsidiary companies.

Fourth.—That if without previous consent voluntarily he shall have quitted the service of the Corporation or of its subsidiary companies, he shall forfeit all right to this stock, and in such case it will be held in a fund which at the end of five years will be divided among such employees as shall have complied with all the conditions.

Thus 25 per cent. of all money set aside in this profit-sharing plan will be held for five years and will be given to such only as at the end of that period shall be in the employ of the Corporation or of one or another of its subsidiary companies from and since January 1, 1903.

As the value of the interests of the United States Steel Corporation in the several subsidiary companies necessarily will be enhanced by everything that tends to increase their efficiency and earnings, this offer includes their employees as well as those of the Corporation itself.

By order of the Finance Committee.

UNITED STATES STEEL CORPORATION,

GEORGE W. PERKINS,
Chairman.

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CONSTITUTION AND BY-LAWS.

THE U. G. I. BENEFICIAL ASSOCIATION OF PHILADELPHIA.

1904.

CONSTITUTION.

NAME.

ARTICLE I.

This Association shall be known as The U. G. I. Beneficial Association of Philadelphia.

OFFICERS.

ARTICLE II.

Section 1. The officers of this Association shall consist of a President, Vice-President, Secretary, Assistant Secretary, Treasurer, Assistant Treasurer, and fifteen Trustees, to be nominated annually at the meeting in December and be elected at the meeting in January.

Sec. 2. It shall be the duty of the President, who shall be *ex-officio* a member of the Board of Trustees, to preside at all meeetings of the Association and of the Board, to countersign all checks signed by the Treasurer, to appoint all committees, except as hereinafter provided for, and to perform all other duties pertaining to the office. He shall serve without compensation.

Sec. 3. It shall be the duty of the Vice-President to preside in the absence of the President and perform all duties pertaining to that office, and his performance thereof shall be conclusive evidence of his right to act. He shall serve without compensation.

Sec. 4. It shall be the duty of the Secretary to keep a correct record of the proceedings of the Association, to collect all dues and assessments of members (keeping a record of same), paying such money to the Treasurer, taking his receipt therefor. He shall give written notice to members who are one month in arrears, and perform such other duties as the Association

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may require. He shall furnish to the Association a bond with such surety and in such amount as shall be approved by the Board of Trustees, the premium upon which shall be paid by the Association. He shall serve without compensation.

Sec. 5. In the case of the absence of the Secretary, or of his inability to act, it shall be the duty of the Assistant Secretary to perform all the duties of the Secretary, and his performance thereof shall be conclusive evidence of his right to act. He shall serve without compensation.

Sec. 6. It shall be the duty of the Treasurer to receive all money in the name of the Association and to pay only in accordance with the Constitution and By-Laws of the Association and as ordered by the Board of Trustees. All checks shall be signed by the Treasurer and countersigned by the President. The Treasurer shall furnish to the Association a bond with such surety and in such amount as shall be approved by the Board of Trustees, the premium upon which shall be paid by the Association. He shall serve without compensation.

Sec. 7. In the case of the absence of the Treasurer, or of his inability to act, it shall be the duty of the Assistant Treasurer to perform all the duties of the Treasurer, and his performance thereof shall be conclusive evidence of his right to act. He shall serve without compensation.

8. The Trustees shall appoint a Membership Committee of five members. They shall also determine the amount and surety of the bonds of the various officers of this Association.

ARTICLE III.

Section 1. Candidates for membership in this Association must be at time of application employed by or connected with the United Gas Improvement Company or affiliated companies located in Philadelphia.

Secc. 2. Applications for membership must be presented in writing to the Board of Trustees, giving name, age, residence, and occupation, attested by the head of the department where said applicant may be located. The application (with the name of the member proposing same attached) shall be accompanied by an entrance fee of one dollar and the first month's dues, which shall be returned should the applicant be rejected. The

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application shall be referred to the Membership Committee, who shall inquire into said application, and if the application is in proper form and the applicant eligible for membership in the Association, the applicant shall be declared a member and be entitled to all the benefits and privileges of the Association.

ARTICLE IV.

Section 1. The monthly dues of each member shall be twenty-five cents, payable in advance at each stated meeting of this Association.

Sec. 2. Upon the death of any and each member there shall be an assessment of twenty-five cents, payable at the next stated meeting, unless there shall be a surplus in the Treasurer's hands of at least $1,500, said assessment to again become operative when the surplus in the Treasurer's hands shall be reduced to $500, and in no case shall there be more than one assessment in any one month.

Sec. 3. Any member who shall be in arrears for two consecutive months shall thereupon cease to be a member of this Association, and shall immediately forfeit all rights and privileges of membership in the Association, except the right of reinstatement within twelve months after the failure to pay dues, such reinstatement to be immediately declared by the Membership Committee upon the presentation of application of the same character as provided for in Section 2 of Article III., and upon the payment by said person to the Secretary of the regular initiation fee of one dollar, together with the first month's dues of twenty-five cents.

Sec. 4. Any member who shall not pay a death assessment as prescribed in Article IV., Section 2, within thirty days after the same is made, shall thereupon cease to be a member of the Association and shall immediately forfeit all rights and privileges of membership in the Association, except the right of reinstatement within twelve months after the failure to pay assessment, such reinstatement to be immediately declared by the Membership Committee upon the presentation of application of the same character as provided for in Section 2 of Article III., and upon the payment by said person to the Secretary

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of the regular initiation fee of one dollar, together with the first month's dues of twenty-five cents.

ARTICLE V.

Section 1. Upon notification to the President, of the death of a member the President shall select one of the Trustees, whose duty it shall be to immediately inquire into the reported death of the member, and if he shall find such death has occurred, he shall report the same to the Secretary in writing. The Secretary shall thereupon inform the Treasurer of this fact and file with the Treasurer the report signed by the Trustee. The Secretary's notice, together with the report of the Trustee, shall be the authority of the Treasurer and President to sign and countersign check of the Association for the payment of the benefit, which shall be the sum of $150. Payment of benefit on account of the death of a member shall be made within three days after notice of death to the President, to such person or persons as said member shall designate in writing, either upon his original application for membership or by written designation filed subsequently thereto with the Secretary of the Association. If there be no such designated beneficiary living at the member's death then the said benefit shall be divided,distributed, and paid by the Association to and among the persons who would be entitled to receive the same in accordance with the laws of the State where such person is domiciled in cases of intestacy. In any case in which notice in writing of the existence of any such person shall not be served on the President of the Association within twelve months after such member's death, it shall be treated as conclusive that there are no such persons in existence, and thereupon the said benefit shall be treated as absolutely lapsed and extinguished.

ARTICLE VI.

Section 1. No assignment of benefits shall be recognized by the Association, and if the right of the beneficiaries designated by the members in accordance with this Constitution to such benefits shall in any manner become alienated, the obligation to pay such benefits shall thereupon cease.

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ARTICLE VII.

Section 1. This Constitution shall become effective December 16, 1904.

ARTICLE VIII.

Section 1. No alterations or amendments shall be made to this Constitution except the same be proposed in writing at a stated meeting, when it shall be laid over for consideration at the next stated meeting, and notice of which shall be mailed or delivered to all members of the Association ten days prior to such meeting.

BY-LAWS.

ARTICLE I.

Section 1. The stated meetings of this Association shall be held on the sixteenth day of each month, save when that day shall be a Sunday or a legal holiday, in which case it shall be the next secular day following that date.

Sec. 2. Fifteen members shall constitute a quorum, but a less number may meet and adjourn from time to time.

ARTICLE II.

Section 1. Meetings of the Board of Trustees shall be held at the call of the President or at the request of three members of the Board.

ARTICLE III.

Section 1. Every member must give his place of residence to the Secretary, and in case of removal he shall notify the Secretary thereof. All notices sent to the address appearing on the books of the Secretary shall be deemed to be the correct address of the member.

ARTICLE IV.

Section 1. The funds of the Association shall not be used for any other purpose than for the death benefits and the legitimate running expenses of this Association.

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ARTICLE V.

Section 1. No part of these By-Laws shall be altered, suspended, or amended unless a motion in writing be presented one month previous to the day it shall be considered, and notice of which shall be mailed or delivered to all members of the Association ten days prior to such meeting; and if two-thirds of the members present vote in favor of the motion, it shall be adopted.

RULES OF ORDER.

No. 1. The President shall take the chair at the hour at which the Association meets, and upon the appearance of a quorum he shall open a meeting.

Business shall be taken up in the following order:—

Call to order;
Reading of the minutes of the last stated meeting;
Reports of Trustees;
Reports of Committees;
Payment of dues;
Report of delinquent members;
Unfinished business;
New business;
Secretary's report;
Adjournment.

No. 2. A motion when made must be seconded before it can be debated. When a question is under debate no motion can be received except to divide, amend, indefinitely postpone, lay on the table, or adjourn. A motion to adjourn is always in order and is not debatable.

No. 3. Every member must when speaking address the presiding officer. On questions of order no member shall speak more than once. On all other questions members may speak twice, not oftener, unless by the consent of the presiding officer.

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THE PROCTOR & GAMBLE CO.

CINCINNATI, O., Aug. 19, 1907.

MR. ALANSON P. LATHROP,
New York City, N. Y.

Dear Sir.—Your favor of the 12th inst. has our attention.

We enclose herewith the reprint of an article which our General Manager wrote for the New York *Independent* some years ago. The Plan and our experience in connection with it were practically unchanged up to July 1st, 1903. At that time there was a modification which we believe will strengthen the cordial relations which exist between our Company and its employees.

We now require that an employee, to share in the Profit Sharing Dividend, shall own Common Stock of the Company to an amount equal in market value to a year's wages or salary. If an employee does not hold this amount of stock we offer to buy it for him or for her. When the purchase is made, a small first payment is required, and other small annual payments are required until the cost of the stock has been paid. Interest is charged in the meantime at the rate of 3 per cent. per annum and the employee is guaranteed by the Company against decline.

The majority of our employees have taken advantage of this offer and will hereafter receive a Profit Sharing Dividend and also the regular Dividend which is paid to holders of the Common Stock.

These Dividends of late years have been 12 per cent; that is, an employee earning $500.00 year in wages or salary gets a Profit Sharing Dividend of $60.00 in addition to the 12 per cent. Dividend on his stock.

If the employee is indebted to us for stock purchased for his account, the dividends are credited to him until the stock is paid for.

It will be evident to you that our object in amending our plan and in encouraging our people to become stockholders, is to have them feel the additional interest in the welfare of the Company which comes from actual investment and part ownership.

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The details given above will, we hope, be interesting, and if we can add anything in the way of information, do not hesitate to call upon us for it.

Yours very truly,

THE PROCTOR & GAMBLE CO.,
By R. H. Rogers.

AN EXPERIMENT IN PROFIT SHARING.

Any change in the methods of conducting the productive and distributive business in the world, to be successful and generally adopted, must first and last have in it that which tends to lessen the cost of such production or distribution. However desirable profit sharing may appear to us from other points of view, this is the essential principle upon which its success or failure depends. Unless the employer increases the efficiency of his labor under the profit sharing plan to at least the extent of the profits so paid to his labor, he should not, as a business proposition, adopt it. If, however, the reverse is true and he increases the efficiency of his labor to an extent greater than the amount so paid to it, it is as incumbent upon him to adopt the profit sharing plan, as it is to put in an improved piece of machinery, remembering also, that it is the first who in adopting improved methods secures the greatest reward. If profit sharing can show that where it is honestly and considerately administered, it is the means of developing in the employee that feeling of self-interest in his labor, which will tend to secure the same thoughtful and honest efforts as though he were working for himself, then it has demonstrated its right of being, as the main claim of the employer is that the root of existing troubles lies in the fact that the employee takes no interest in his work and has no consideration for his employer's property or welfare.

Now, how can profit sharing prove its ability to produce this change in the employee's feelings? If it can be shown in a manufacturing establishment continuing under the same management, even down to practically the same foremen of departments, that since profit sharing has been introduced, strikes and labor troubles are unknown, where before they were com-

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mon; that the waste of material has been reduced one-half; that the number of employees leaving the employ, or being discharged for cause during the year has been reduced to one-third the number so doing prior to the adoption of the system, and that the actual labor cost of manufacture, including in such cost, the amount of money paid to employees as the profit sharing dividend, has been lowered, then we think profit sharing will be justified in claiming that it has supplied that motive to self-interest in the employees work, which is now admitted to be so sadly lacking.

It was, during the year 1886 that the Knights of Labor began to assume such prominence, and employees in manufacturing establishments throughout the country became more or less restless. During that year the firm of Proctor and Gamble, soap manufacturers, Cincinnati, had in their various departments no less than fourteen different strikes, having at different times from eleven to one hundred and fourteen of their employees quit work in a body, and for all sorts of trivial causes. They were continually at the expense of breaking in new people, and the question was one of constant anxiety. After considerable hesitation, it was decided to put into force a plan of profit sharing and to secure, if possible, some relief from these troubles. It was decided to allow as a portion of the expense of manufacturing, a reasonable salary to each active member of the firm, and to divide the remainder of the net profits between the firm and the employees in the proportion that the labor cost of production bore to the total cost of production. In other words, if the sales were $100,000 and the net profits, after deducting the salaries of the firm, $10,000, then the total cost of production would be $90,000. Assuming that the amount paid for wages was $20,000, then the $10,000 of profit would be divided, seven-ninths to the firm and two-ninths to the employees.

The proposition when made to the employees was accepted in a half-hearted way and without any belief upon their part that it would be of material benefit to them. At the end of the first six months a dividend of 11 per cent. upon the wages was declared. During the next six months there was evidence that some of the employees were beginning to take a little in-

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terest in the working of the plan, and in order to encourage them and to reprimand those who did not take an interest, the plan was adopted of dividing the employees into four classes, the first class getting double the regular dividend and including those who showed unmistakable signs of appreciation of the fact that it was incumbent upon them to help make the profits. The second class received the regular dividend and included the bulk of the employees. The third class were those who did not evince much interest in the plan and whose dividend was one-half the regular amount. The fourth class were those who for cause were cut out of any dividend at all. They continued working under this plan for two years, by which time they had managed to weed out the majority of those who took no interest in their work, and since then have had only two classes, those who share and those who do not. The total amount of profit sharing dividend is not affected by the number of those sharing. If for any reason they are compelled to decline allowing an employee to participate, his share is divided among the others.

This, briefly, is the plan under which The Proctor & Gamble Co. are to-day working. In the year 1887, the first year in which the plan was in operation, they had three strikes during the first six months. Since that time they have had absolutely no labor trouble. We believe it would be impossible to foment any such trouble among the employees now. As an illustration of how they feel, we might mention that it has occurred frequently, that where some troublesome fellow has tried to produce dissatisfaction, the men themselves will come to the foremen and tell them all the details of it and suggest that the man be discharged. The old feelings of discontent and distrust have been replaced by that of mutual interest.

The class of labor employed in the soap factory is of the most ordinary unskilled kind. Over 85 per cent. of our employees earn $1.50 a day or less. This class of labor is the kind that most frequently shift from place to place and is the class which of necessity you must frequently change. We are at the moment without exact figures relative to the proportion of employees who would continue for a year in the factories prior to 1887, but we think it a conservative estimate to say that

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one-half of the employees were replaced each year by new men. Last year, out of over 600 employees, we had six who left or were discharged for cause. Three of these were girls who were married, and two of them were men whom we discharged for being in a drunken fight, even though not in working hours. The sixth employee left for some reason which we do not know. Too much stres cannot be placed upon the advantage of being able to retain the employees year after year. Even though the labor is unskilled, it takes some time to break in a new man so that he is as efficient as one who is familiar with the work to be done.

It is very difficult to determine exactly what proportion of the labor saving that has been effected in our factories, since the profit sharing plan has been in force, is due directly to the profit sharing plan, and what is due to improved machinery and methods of manufacture. Our labor cost of manufacture, including a 12 per cent. profit sharing dividend upon the wages for the year 1894, was 63 per cent. of what it was during the year 1886, and this in spite of the fact that the average rate of wages in 1894 was a trifle over 12 per cent. higher than in 1886. Figuring conservatively, and throwing all questionable items against profit sharing, they estimate that the improved methods of manufacture are responsible for 28 per cent. of the 37 per cent. shown, leaving as a net result to the credit of profit sharing, a saving equal to 9 per cent. plus 12 per cent. increased wages, or 21 per cent. cheaper labor cost of manufacture under the profit sharing system.

As to the saving in material, this also is a difficult question to determine. Unfortunately, it is not possible to keep accurate accounts of saving under this head. We can instance, however, one thing which shows how the profit sharing plan works. One of the principal sources of waste in the factories is due to the waste of scraps and small pieces of soap by allowing them to fall upon the floor and become trampled under foot. This dirty soap used to accumulate so rapidly that it was necessary to work over the accumulation every two or three weeks. Now it takes three of four months to accumulate a sufficient quantity to be rehandled. The effect of sav-

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ing by the employees can also be seen in the general air of tidiness and cleanliness about the factories.

There is no question that in The Proctor & Gamble Co.'s factory, profit sharing has done more than answer the questions propounded above, and the tendency has been, wherever possible, to extend this same profit sharing principle, and to encourage more and more the spirit that it has started among among the employees. This has been done by having employees become interested in the stock of the company, trying to induce them to put their savings into the business for which they are working, so that all their interests shall be in one place. As an instance of the willingness of the employees to bind themselves more closely to their work, we would mention that after the last semi-annual profit sharing dividend, the employees subscribed for $5,250 worth of the common stock of the company.

While the profit sharing plan is to-day working so smoothly and profitably to the interests of the *capital* invested in the business, yet it must not be assumed that it came to this state without any drawbacks or disheartening circumstances. The employees of the company were of the ordinary type of day laborers, ignorant and suspicious; and it was only by absolute fairness and justice in ruling upon all claims and allowances to be made for them, that the management had succeeded in fully gaining their confidence. We do not think that any person who will adopt the profit sharing plan need expect that it will pay its own way for the first two years; but after that, if the employer will do his share of it and treat the employees with consideration and with an effort to show appreciation for any attempts they may make, even though misguided, to improve the work of their department, we feel assured that the ultimate outcome can only be to the more firm establishment of the system. It is by no means an uncommon occurrence now for the employees of The Proctor & Gamble Co. to show decided interest in the character of the goods being shipped, taking especial pride and pains in those in which they assume that the larger profit is made. They will call the attention of the foreman to little questions as to quality of the different brands of soap manufactured, showing plainly a de-

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sire upon their part that they shall do their share in seeing that nothing goes out from the factories which would tend to injure the demand for the products of their labor.

These results have been obtained during a period of time when the feeling between employer and employee generally has been strong and bitter. The spirit of bitterness had already developed in the Proctor & Gamble factories, showing that there was nothing peculiar to their management that would exempt them from the same troubles so many others have had. The results have been obtained not at any cost of profits to the capital invested, but at an actual increase of profits to the capital. All that was done was to allow the employee an opportunity to save money for himself. He did it and more.

We have never been forced to meet the question: What would be done in the event that no profits were earned or that a loss was incurred? We have told our employees that we would not expect them to share in any losses. We feel that even in the event of a year's business showing a loss, it would be an injustice to ask them to bear any proportion of it beyond the loss they already sustained during the year by giving the increased efforts and care for which they received no recompense.—*Wm. Cooper Proctor, in the Independent, May 2.* 1895.

N. O. NELSON MANUFACTURING CO., ST. LOUIS.

There are new customers and new readers who do not know our business plan. There are some old ones who have forgotten, and some who never get it clearly in mind. It will bear restating. We are an ordinary corporation, doing business in the ordinary way. Employees are paid full salaries and wages. Customers buy goods at market prices. I own the majority of the Capital Stock, for which I take no part of its annual earnings. The stock owned by the employees and the customers gets 6 per cent. annual cash dividends. We spend some money on educational and social work among our employees. We care for our sick and disabled, and we spend some on public benevolence; this takes about one-fifth of the entire profit. The other four-fifths is divided among the

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employees and customers; it is paid in my stock at its face value. The dividend to employees is in proportion to their pay. The dividend to customers is in proportion to the Profit we make on their purchases. We divided among ourselves last year, 1906, $177,500.00 from the profits of the year. "We" means all the employees and all the customers of the N. O. Nelson Mfg. Co. (Employees who have worked less than six months and customers who have traded less than $100.00 within the year are not counted.) We didn't pay out the money, but added most of it to the working capital. We made some additions to our factories, built homes, and made other good uses of it. The employees and customers got stock in the Company for their shares, and before long they will own the Company. That labor got 25 per cent. dividend last year in place of 15 per cent. the year before, and the customers an average of 7 per cent. on purchases instead of 4, was partly or mainly due to the co-operative interest of both. The proportion for the present year will be the same as last year, as 5 on wages is to 9 on customers' Gross Profits. If times continue good and the employees improve, and the customers buy more, with no increased expense, then the dividend rate will be larger, and the total larger. Reversing these conditions, they will be smaller. Paying the dividends in stock serves the purpose of increasing the capital to take care of more business, transferring the ownership from me to the employees and customers, making it co-operative in place of private, and securing a 6 per cent. cash stock which is better standby for the uncertain future than can be had in any other way. The stock is the absolute property of the holder, there is no string to it. To safeguard the plan, the stock is made transferrable only on the books of the Company. We have adopted the regulation co-operative plan of half-dividend to non-members; that is, those who prefer a cash dividend rather than a stock dividend. He may take his half dividend in cash and remain a non-member, or he may take full dividend in stock and be a member. It is optional with him. The plan is to turn the whole business over to employees and customers without any payment from them, the dividends paying for the stock. When that is done, they will own a large and very valu-

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able property, the big St. Louis store, the splendid Leclaire and Bessemer Factories, the stocks of goods in St. Louis, Leclair, Bessemer, Los Angeles, San Francisco and Pueblo.

MR. W. H. GARDINER: That portion of the Report covered on pages 548 and 549 is the report of the whole committee, and it is the only statement for which the whole committee is responsible. In addition to that, each sub-committee, with the exception of that on Taxation and Franchises, has drawn a report through the general committee. Our time is very limited indeed this afternoon, and, therefore, while the questions of Publicity and Popular Education, Industrial Insurance and Rewards and Pensions, are very important, unless there is objection, I will pass those over in the discussion and presentation of this matter and take up only the question of Public Regulation and Control, and the London Sliding Scale as applied to Gas. I hope that no one will hesitate to correct me if I am in error in saying that those two questions are perhaps, and particularly the question of Public Regulation, are the most pressing in our thought at the present time. Therefore, with your permission, I will read the report of the sub-committees on those two subjects. The first is the report of the sub-committee on Public Regulation and Control, that sub-committee being composed of Mr. F. W. Little, Chairman, and Mr. A. P. Lathrop.

(Mr. Gardiner read the report of the sub-committee on Public Regulation and Control to the Public Policy Committee, as covered on pages 550, 551 and 552 above.)

After that follows the report of the sub-committee on the London Sliding Scale as applied to Gas. I will not attempt to read this report in full as it covers some ten pages. With your permission, however, I will make a verbal introduction, and then read a portion which I think should be called to your attention. The London Sliding Scale is not a matter of rates or anything of the kind. It is a reciprocal arrangement or device which may be entered into by a company under regulation, consisting in simply saying to the corporation, "Now if you will continue lower prices, we will allow

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you to pay a proportional increase on the earnings over and above your initial fair returns, because we find that by making it worth your while to do that, we can get better results than by continually hammering you down to a minimum of return which you can insist on under the 14th amendment to the Constitution." That is the whole thing. This device has been used in Boston for some time, a matter of eighteen months or so, and has worked very well there, so I am told, but I think that the American Gas Institute should not at this present moment advise its general adoption because of the conditions there; for the reason that it is bringing about a very marked change in local conditions which may have its contagious effect elsewhere. Therefore, with your permission, I am going to read an extract from a statement published last June.

(Mr. Gardiner read from the report of the sub-committee on the London Sliding Scale as applied to Gas, as given upon pages 553 to 559 above.)

There is only one word that I want to add to that. There are many methods of arriving at such an arrangement, but I want to urge upon the Committee or upon the members of the Institute to give very careful consideration to this plan. I consider the English plan, however, to be very deficient in a great many points. There has been more or less criticism in this country, especially in the National Electric Light Association, and from various sources, of the methods of arriving at these ends, but I trust that the members of the Institute will give it careful attention with the idea of eliminating certain things which may suggest themselves.

I trust, gentlemen, that we shall hear some discussion on this question.

THE PRESIDENT: Gentlemen, you have heard the report of the Public Policy Committee. Are there any remarks?

DR. A. C. HUMPHREYS: Mr. President, I would like to say a word or two in regard to the last sub-report in reference to the London Sliding Scale. I do not wish now to discuss the merits of the scheme. It unquestionably has merit if properly applied in connection with local conditions, but I feel that the

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Boston experiment, as a whole, is going to be misleading to the public and to public officials. Conditions there are decidedly local, and unless those local conditions are understood, or if the Boston scheme is understood to be generally applicable, the gas companies of the United States are going to have trouble.

I would like to draw attention to one other feature, and that is, that possibly, in view of the way in which the report was prepared, it might lead to a misunderstanding. In England, the standard rate is fixed on a fairly generous basis, and hence the companies have a good working chance to cut the price. In the United States the tendency appears to be to fix a price upon a so-called fair rate of return, but in reality a low rate of return upon a low rate of capitalization. Such a policy would at once defeat the object arrived at by the sliding scale scheme.

MR. A. S. MILLER: Mr. President, I did not understand whether the Committee recommended that the Institute go on record as favoring the adoption, by all states, of gas commissions and whether the adoption of this report would commit the Institute to such a recommendation.

THE PRESIDENT: What you want to know is rather, what the language of the Committee's report is on that matter?

MR. A. S. MILLER: That is it exactly, and what the adoption of the report is going to carry with it.

MR. GARDINER: Perhaps I can best answer that by quoting from the report itself. One of the conclusions of your subcommittee was: "That the change from the policy of open competition as a regulating force, and from secret accounting to State Supervision and regulation with public accounting, is not inimical to the interests of the owners of gas properties provided that it is accompanied by protection to the values of the properties supplying the public need. Such protection is as necessary to the public interest as to the corporations, since without it, capital cannot be secured to make necessary extensions and improvements."

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The sub-committee also makes other recommendations. Does that answer your question?

MR. A. S. MILLER: I think I understand what the recommendation is.

MR. PAUL THOMPSON: I understand that automatically the report which has been submitted by these sub-committees will be referred to the Public Relations Committee under the Constitution.

THE PRESIDENT: Yes.

MR. JOHN D. SHATTUCK: I move that the Public Policy Committee be discharged with the thanks of the Institute, and that the report be referred for consideration to the Public Relations Committee.

Motion seconded.

THE PRESIDENT: Gentlemen, you have heard Mr. Shattuck's motion, which has been duly seconded. The motion is that the Committee be discharged with the thanks of the Institute, and that the report be referred to the Public Relations Committee. Those in favor say "Aye." Contrary minds, "No." The motion is passed.

The next matter on the program is the report of the Rate Committee, Mr. Gardiner, Chairman.

REPORT OF COMMITTEE ON RATES.

MR. W. H. GARDINER: Mr. President and Gentlemen: The Committee on Rates is in a peculiar position. At the last convention they outlined a long program for the study of the rate problem, and in this, their second report, they undertook to take the first step on that program, which was primarily to study the cost of definite gas service through a company as supplied to one customer, and the detailed condition and situation was intended to be thoroughly gone into. The report was prepared last June and was passed to one of the other members of the committee. It finally reached the Secretary's hands on the 1st of September, or about that time, I think.

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The Chairman had written to the Secretary, making it very clear that the intent of the committee was solely to prepare a report which would bring out discussion on this vital question, and second, that the committee absolutely refused to make a report or take upon itself the responsibility of presenting or crystalizing for this organization the question of the cost of the conduct of the business. We were simply trying to do what was thought would be of help to you, and it is up to you to make the statement. This report was drawn in such terms, and the committee has internal evidence of the most positive kind to the effect that it is impossible to discuss this report thoroughly, intelligently and aggressively unless it has been studied. Two members of the committee when asked said that they would under no circumstances, even with some unusual knowledge of rates, think of discussing the matter unless they had time to prepare themselves. The Chairman made the point plain and issued a special request, so that it could be studied. in order that it might be thoroughly discussed, or at least get opinions which would relieve the committee of further responsibility. The report was passed by the Board of Directors, but, unfortunately, there was a misunderstanding, and it was withheld from printing without the chairman of the committee having been notified, and it occurred too late for him to take any effective action. The committee, therefore, beg leave to withdraw the report subject to such further action as the Institute wishes to take in the matter.

In conclusion, the committee wishes to lay emphasis upon the great importance of this rate work. We want to lay emphasis on the fact that in the last year we saw more progress on behalf of technical men and public officials than has been made, I think, in the study of the question of rates and in the understanding of rates in any five years previous. I trust that something of this nature will be carried out in the future.

MR. IRVIN BUTTERWORTH: In view of the importance of this matter, and the fact that the committee finds itself in this situation, I move that the committee be continued.

MR. H. L. DOHERTY: Mr. President, I am a member of that committee. I do not want to discourage Mr. Butterworth

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but as his motion is not seconded, I will move that the committee be discharged.

THE PRESIDENT: Two motions have been offered. There is no second to either.

A MEMBER: Mr. President, I will second Mr. Doherty's motion.

THE PRESIDENT: Mr. Doherty's motion is seconded. Are you ready for the question? Those in favor please say "Aye." Contrary "No." It is carried.

The next business in order is a lecture on Electrolysis by Professor A. F. Ganz, of Stevens Institute.

ELECTROLYSIS.

BY ALBERT F. GANZ, M. E.

At the last meeting of the Institute the Committee on Electrolysis, for which I had the privilege of acting as consulting electrical engineer, presented a report which contained abstracts of the most important reports and papers, on the subject of electrolysis from stray currents, published in America and Europe, together with conclusions and recommendations for the protection of underground pipes, and also a brief outline of the theory of electrolysis. The reports of electrolysis tests which have been published since then show generally the same results as the ones which were quoted, and I can endorse the conclusions and recommendations reached by the Committee more strongly to-day than when they were adopted.

In the discussion of the theory of electrolysis, it was stated that wherever current passes from a pipe to ground, electrolytic corrosion takes place and that a mere fraction of a volt may produce corrosion. It has been claimed by others that a voltage below 1½ volts cannot produce corrosion because it is below the dissociation voltage of water; this, however, is a mistake, because when current passes from iron through ground to iron and produces corrosion the counter electromotive force

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is only a small fraction of a volt. If current should leave an iron pipe in ground containing certain alkalies, the iron would be in what is known in chemistry as the "passive" state, and oxygen would be liberated without producing corrosion. In this case there would be a counter electromotive force of 1½ volts, due to the dissociation of water, opposing the flow of current in such passive places.

This passive condition of iron has also been put forward as a source of protection for iron pipes. The question has been investigated by Professor Haber* of Karlsruhe, who has found that this passive condition of iron rarely exists in the case of iron pipes in ground. The electrolytic effect of current leaving passive iron would in fact be to change the alkaline to an acid condition and so render the iron active, that is, subject to corrosion. If there should be both active and passive portions in a positive pipe, the current would leave largely in the active places, because in the passive places there is the opposing electromotive force of 1½ volts, so that a corresponding increased density of current and of corrosion is set up in the active places where there is practically no counter electromotive force. I cannot see therefore that we can derive any encouragement for the protection of pipes from this theory of the passive state of iron.

A number of laboratory investigations on the effect of alternating current in producing electrolysis have also been published, and these indicate that an alternating current will produce electrolytic corrosion which is very much dependent upon the composition of the soil, and which varies in amount from a fraction of one per cent. to possibly two per cent. of the corrosion produced by an equivalent direct current. It would appear from this that in certain cases, particularly in the case of a lead pipe, even an alternating current may produce destructive corrosion. No experiences with stray alternating currents have, however, as yet been made public.

In Germany a special form of electrode for measuring earth potentials, which does not introduce uncertain polarization potentials, has been used and also a special apparatus for direct-

* See Zeitschrift für Elektrochemie, Jan. 26th, 1906.

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ly measuring the current flowing through ground. These were devised by Professor Haber, who has called them "non polarizable electrode" and "earth amperemeter" respectively; he has used them in an extensive series of tests upon the piping system of Karlsruhe. A description of the electrode and earth amperemeter, together with the results of these tests, were presented in a paper before the Deutscher Verein von Gas und Wasserfachmännern, which is published in their transactions for 1906. These devices have also been used with success during the past year in the tests made by the German Electrolysis Committee.

The mode of testing a piping system for stray currents is of considerable importance and interest to gas engineers; as this was not touched upon in the report of last year, I will in what follows endeavor to give an outline of suitable methods for making such tests, and also briefly describe the construction and uses of the new German devices. I will lay special stress on methods which will serve to prove that corrosion was due to stray currents and to prove the origin of these currents so as to fix the responsibility, as this is important and essential evidence in case of a lawsuit.

With the arrangement, usual with trolley roads, of connecting the negative terminal of the generator to the rails, the general path of the stray currents is from the rails through ground to the pipes at places distant from the power house, through the pipes, and from these through the ground back to the rails or to other return conductors in the vicinity of the power house. Where current flows from a rail to a buried pipe, the rail assumes a positive potential with reference to the pipe; where current flows from a buried pipe to a rail, the pipe assumes a positive potential with reference to the rail.

The first step in making an electrolysis survey of a piping system is therefore to measure potential differences between pipes and rails in a large number of places throughout the system in order to locate these points of current flow between pipes and rails. As gas mains are not generally accessible, service or drip connections are used for making connection with the voltmeter; for this purpose one voltmeter wire is clamped or

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otherwise fastened to the drip or service connection, care being taken to clean with a file the part where the wire is fastened so as to insure good metallic contact. The other voltmeter wire is best soldered to a rough flat file which is held on the rail for the contact, and which can be quickly removed and replaced when a car passes. The voltmeter for these measurements should have a high resistance so that an accidental poor contact at a drip or service connection will not seriously interfere with the measurement. A suitable instrument is a portable high resistance Weston voltmeter with zero center, having ranges of 1.5, 15 and 150 volts. Readings should be taken every ten seconds for ten minutes at each point, and the maximum, minimum and average reading noted.

The average readings are then conveniently marked upon a map showing the principal pipes and tracks, red numbers being used where the pipes are positive to the rails and black or blue numbers where these are negative. An excellent plan is also to plot these potential differences graphically upon a map on which the pipes are shown as lines and using these lines for axes, and the voltmeter readings for ordinates; by shading the areas between the potential curves and the pipe lines with red where the pipe is positive and with black or blue where it is negative to the rails, a clear representation of the potential distribution is obtained. If the negative bus bar of the power station is connected to ground plates or to other buried metal as cable sheaths, measurements of potential differences between these and the pipes should also be made and plotted upon a separate map.

It will generally be found that there are definite regions in the neighborhood of supply stations and of return feeder connections in which the pipes are always positive to the rails; and that there are other definite regions, remote from the first, in which the pipes are always negative to the rails. Between the positive and the negative regions the potentials will be found to fluctuate from positive to negative.

The existence of potential differences between pipes and rails, even if large, is however no conclusive evidence of stray currents, but indicates at what points current may be flowing

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from rails to pipes and at what points it may be flowing from pipes to rails or to other return conductors. A high potential difference is, in fact, usually a sign that there is a high ground resistance and consequently but a small current flowing.

The next step is to determine the direction of the probable current flowing in the pipes. This is done by measuring potential differences between two points in a pipe by means of a millivoltmeter. A convenient instrument for these measurements is a zero centre Weston millivoltmeter with two scales, one of ten and the other of one hundred millivolts. These measurements may be made between drips or service connections from fifty to two hundred feet apart. These measurements cannot be used, however, for calculating the current strength in the pipes, but only to indicate the probable existence and direction of this current. This direction of flow is then marked upon the map, together with the potential readings.

In making these tests it is important that the connecting leads used with the millivoltmeter be rubber covered wires so as to have a good insulation and to prevent the wire if coming in contact with wet ground from taking the potential of the ground and disturbing the readings. A good wire for this is No. 14 rubber covered and double braided wire. I remember one instance where we were measuring the drop along a cable sheath on a wet day, getting readings of from one to two millivolts; during one of these readings the needle suddenly ran off the scale, and a voltmeter, which was substituted, indicated two volts. We found upon investigation the connecting wire lying in water, the insulation defective, and that we were, therefore, getting the potential difference between the cable sheath and the surface of the ground instead of the drop in the cable sheath.

A study of the map will show at what points determinations of current strength should be made. This is done by measuring the drop in potential between two points in the pipe by means of a millivoltmeter, and dividing this by the resistance of the included length of pipe. If this length contains one or more joints this resistance must be measured and not estimated, because joints make contacts of extremely variable resistance.

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As this resistance measurement is troublesome to make, it is generally more convenient to measure the drop in potential between two points in one continuous length of pipe. A sketch of this arrangement is shown in Fig. 1. With very large pipes and small current, this drop is a fraction of a millivolt and requires a specially sensitive millivoltmeter reading to hundredths of a millivolt for its measurement. The resistance of the length of pipe can be calculated from its dimensions and from an assumed figure for the conductivity. Mr. Maury, in a paper* before the American Water Works Association, has

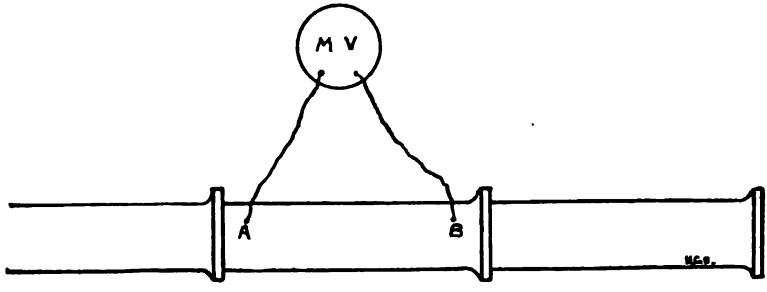

Fig. 1.—Connections for Measuring Current in Main.

given convenient tables for converting drop in millivolts directly into amperes of current for cast-iron and for wrought-iron pipes. These tables are based upon a resistance of 0.00144 ohm per pound-foot for cast-iron and of 0.000181 ohm per pound-foot for wrought-iron; these figures were obtained from measurements upon a large number of pipes and agree well with those given by others and with measurements made by the writer. To find the resistance of any cast or wrought-iron pipe per foot of length, it is only necessary to divide the above figures by the weight of the pipe per foot. In the accompanying table I have given the weights and resistances per foot for the usual sizes of cast and wrought-iron pipes, the resistances being based upon the above figures for the pound-foot.

* "Surveys for Electrolysis and their Results." A paper read at the 23d Annual Convention of the American Water Works Association, held at Detroit, Mich., June 23-26, 1903.

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WEIGHT AND RESISTANCES OF CAST AND WROUGHT IRON PIPE

Inside diameter of pipe Inches.	STANDARD CAST IRON		STANDARD WROUGHT IRON		EXTRA HEAVY WROUGHT IRON	
	Weight per foot without Hub Pounds.	Resistance per foot Ohms.	Weight per foot without Hub Pounds.	Resistance per foot Ohms.	Weight per foot without Hub Pounds.	Resistance per foot Ohms.
¼			.84	.000215	1.1	.000164
½			1.7	.000106	2.2	.000082
1			2.7	.000067	3.6	.0000502
1¼			3.6	.0000502	5.	.0000362
2	11.	.000131	7.5	.0000241	10.	.0000181
3	18.	.000080	10.6	.0000171	15.	.0000121
4	31.	.0000465	18.8	.00000963	29.	.00000623
6	42.	.0000343	28.	.00000647	43.	.00000421
8	55.	.0000262	40.	.00000452	54.	.00000335
10	70.	.0000206	49.	.00000369	65.	.00000278
12	109.	.0000132				
16	130.	.0000111				
18	151.	.00000955				
20	205.	.00000702				
24	294.	.00000490				
30	408.	.00000353				
36	604.	.00000238				
48						

A matter of great importance in making these current measurements is to be sure to have perfect metallic contact between the pipe and the millivoltmeter wires. It will not do to use drip or other fittings for this connection, but contact must be made directly with the metal of the pipe. It is, therefore, necessary to expose the pipe where a current measurement is to be made.

I have made tests with various methods of making contacts for current measurements upon a rusty pipe, and have found that the presence of oxide may produce such a high resistance as to prevent a reading. I have also found that moisture can produce an electromotive force due to electrochemical action so large as to entirely offset the reading due to drop by the current. A satisfactory method is to use a pointed piece of steel about half the size of an ordinary lead pencil, with the connecting wire soldered to it, and provided with a wooden handle, the soldered joint being inside of the handle; this steel contact is pressed against a spot on the pipe which has been

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previously filed bright. By far the best contact is, however, obtained by soldering the connecting wire directly to the pipe; this is particularly advantageous when readings are to be taken over a considerable time. This soldering should be done by means of a torch and sufficient time allowed for the joint to cool to the temperature of the pipe before using it, as otherwise a thermo-electromotive force may be set up which disturbs the reading. When such contact wires have been soldered to a pipe it is convenient whenever practicable to continue these with rubber-covered wires to the surface, or to some accessible point, and to terminate the ends in small iron boxes such as drip boxes; these wires are then available for future current measurements on the pipe without going to the labor of again exposing it.

These readings of current should be taken every ten seconds for at least ten minutes, and the maximum, minimum and average readings noted.

By tracing the flow of currents found in the pipes from these measurements, points can be usually located at which current must be leaving the pipes, and the pipes should be exposed here and examined for evidences of electrolytic corrosion. It must be remembered that all current which is found flowing in a pipe must leave it somewhere in order to return to the negative pole of the generator. This follows from the fact that every electric circuit must be completely closed so that every ampere which leaves the positive pole of the generator must eventually return to the negative pole, no matter how long or complicated the path through which it passes may be. Electricity is, in this respect, very different from gas or water, which latter may escape from a leak and diffuse through the ground. It is for this reason that stray currents represent no loss of electricity to the railroad, as is sometimes supposed, but are on the contrary a gain inasmuch as the ground and pipes offer additional return paths for the railway current and, therefore, mean less drop in the return circuit. It is for the purpose of taking advantage of the earth as a return conductor that railway power stations frequently use large ground plates connected to the negative bus bar with heavy copper cables.

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The previous brief outline of tests will serve to locate the points in the positive district in which there is the greatest danger from electrolytic corrosion, and these tests are relatively easily made and constitute the electrolysis survey as ordinarily made in America.

There may, however, be many other endangered points which these simple tests will not reveal. Stray currents do not always take the simple path from rail to pipe, along the pipe and back to rail or other return conductor, but frequently take roundabout paths, passing from one piping system to a second system, from this, perhaps, to a third system or passing across pipes, shunting around high resistance joints, etc., producing electrolytic corrosion at every point of leaving the pipe for ground. These points may exist in the negative, neutral or positive districts and are much more difficult to locate by means of electrical measurements.

The writer has in mind a striking case of this kind which he saw while witnessing some tests made by Mr. A. A. Knudson, in Rutherford, N. J. A water pipe crossing under trolley tracks was badly corroded with all evidences that the corrosion was electrolytic, yet this pipe was always over one volt negative to the rails and, therefore, could not be giving up current to these rails. Upon further investigation it was found that an oil pipe crossed this water pipe several feet away in the ground, and that the water pipe was highly positive to this oil pipe. It was, therefore, clear that the current which was producing the corrosion was leaving the water pipe and entering the oil pipe.

Wherever there are two or more independent piping systems, as, for instance, water and gas pipes, measurements of potential difference between these should be made to see if any points can be located where current is likely to be passing from one to the other. Current measurements must then be made in the pipes at these points and plotted and studied as before.

Measurements of current should also be made at every point where a pipe crosses a trolley track or passes through particularly wet ground near trolley tracks to see whether

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current is passing from one to the other, as these are particularly endangered points. For this purpose it is best to expose a length of pipe on each side of the track and to measure the current on each side. It may be found, however, that this current is so fluctuating that it is difficult to draw conclusions from these readings; the passing of a car may produce an entire change in the current conditions. I have found that the best way to make the test under these circumstances is to use one millivoltmeter in the pipe on each side of the track and to take simultaneous readings of current every ten seconds for ten or twenty minutes. The time of taking these readings should include the passing of a car. When these readings are plotted it can be seen by comparing the current curves whether there is a change in the current in the pipe where it passes under the track, and therefore if current is passing from pipe to rail or from rail to pipe at this point. The same method may be applied in any case where it is desired to find out whether there is a change in the current flowing in a pipe between any two points in the pipe. The illustration (Fig. 2) shows two such simultaneous current readings taken in a pipe on each side of a stretch of wet ground in which the pipe was laid for a distance of about 500 feet and only one-half block away from trolley tracks; the agreement of the current curves shows, however, that current was neither passing to nor from the pipe in this wet ground during the time of these tests.

A case where current was entering a pipe from wet ground is shown by the curves in Fig. 3, in which the simultaneous current readings are plotted, taken on each side of the wet ground through which this pipe was passing. The direction of the current flow was from Station A to Station B, the curves showing that during most of the time of the test, current was entering the pipe from the wet ground between these stations.

In making these simultaneous current measurements it is very important that the two millivoltmeters have the same period of oscillation, as otherwise, with the usual fluctuating current, one would lag behind the other in its reading and the instantaneous readings would no longer be comparable. It is desirable to use two exactly similar meters, and these should

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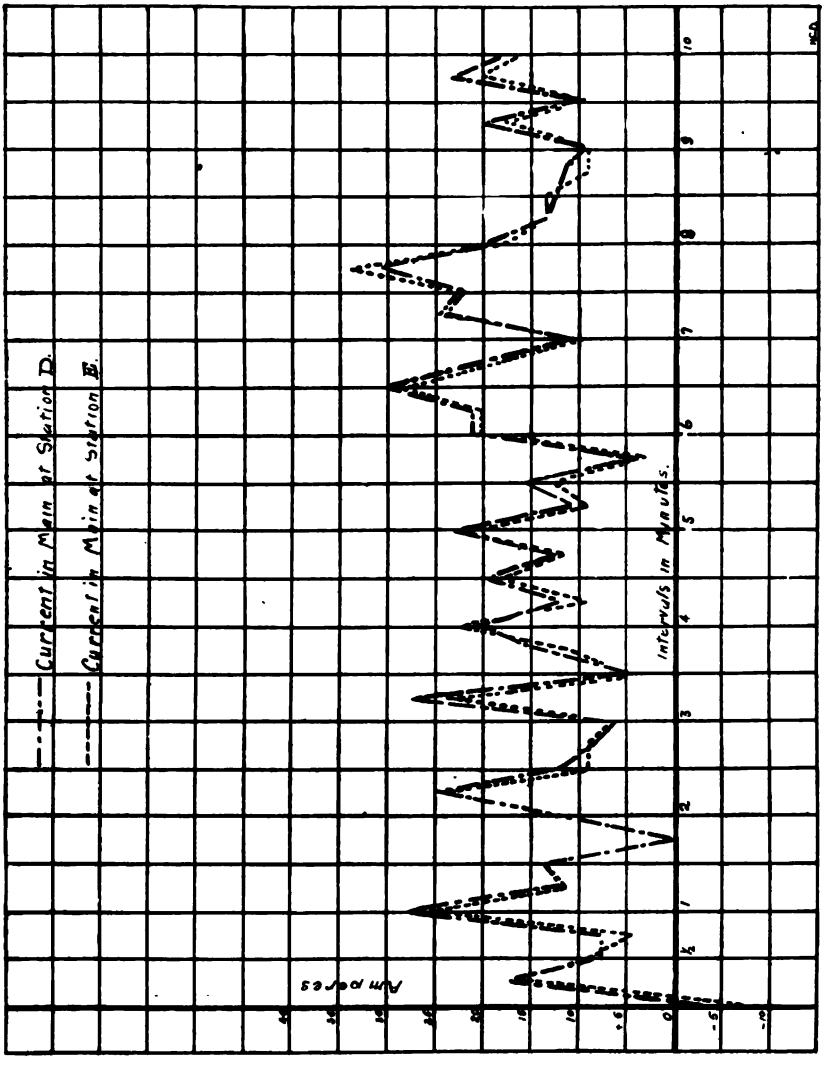

Fig. 2—Simultaneous Current Readings at Two Stations in a Gas Main.

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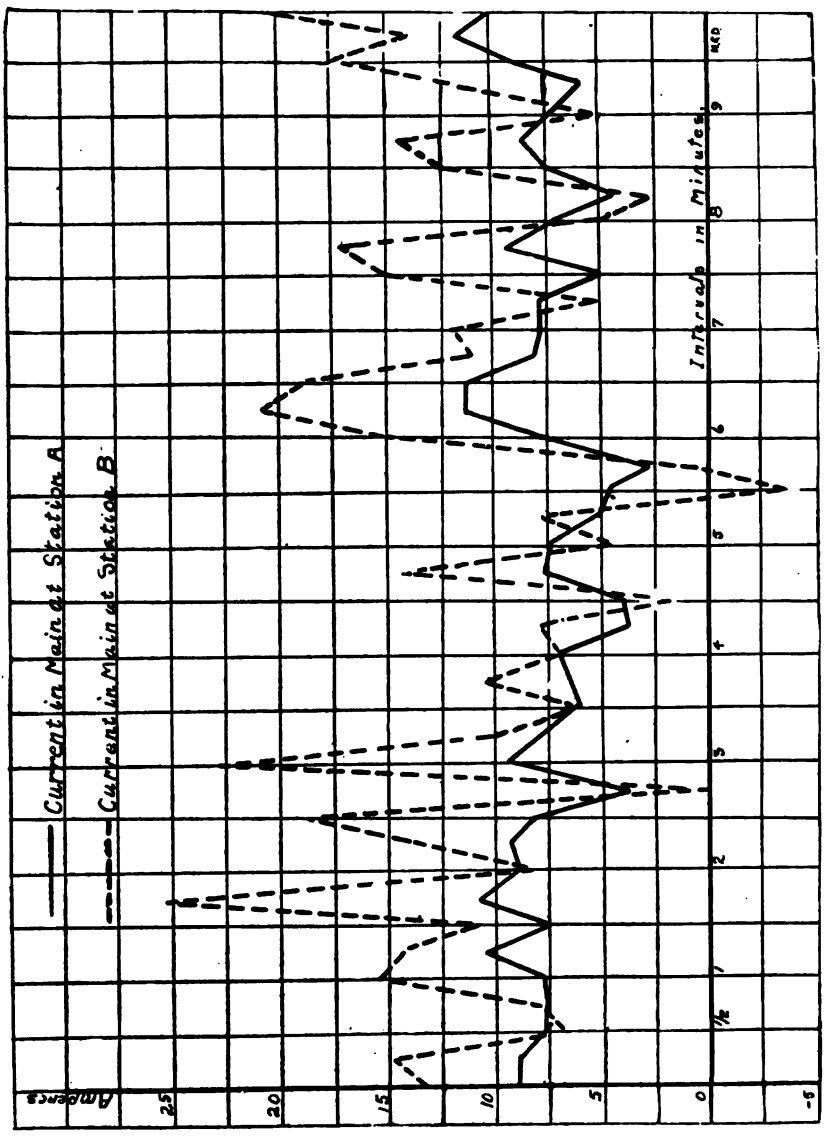

Fig. 3—Simultaneous Current Readings at Two Stations in a Gas Main.

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be strongly damped so as to move slowly enough to enable accurate readings to be taken even with a very fluctuating current.

Another very important matter is the choice of time for making these measurements. The stray currents in the pipe will follow the load curves of the railway, and tests should be made at time of heaviest load as well as at times of light load.

In a large railway system operating a number of stations, some of the stations may be shut down during periods of light load, and the current condition in the pipes be completely changed during these times. If the stray currents in the pipes are the combined leakage current from two or more railway systems, having different load curves, the current conditions in the pipes will also change during different times of the day, and perhaps also on different days. In cases of this kind a recording meter should be applied to a number of characteristic points in the piping system, arranged to record the current in the pipe. I have used a Wm. H. Bristol recording meter (a pyrometer instrument without its thermo couple) to obtain twenty-four-hour records of currents in pipes. The diagram in Fig. 4 shows the current in a gas pipe for four consecutive days, obtained from four Bristol charts by estimating the average current for consecutive one-hour periods and plotting these averages. The records for other week days were about the same as shown for Monday and Tuesday in Fig. 4. The diagram for Sunday shows that the current in the pipe was very large and flowing practically all day in the same direction; this large current is accounted for by the fact that the neighboring trolleys were carrying a large crowd of Sunday excursionists. The following Sunday was a rainy day, and the record showed a much smaller current in the pipe for this day. I want to say that the change in direction of the current indicated in the week-day diagrams is an unusual condition, and probably due to the changes in the operation of the power houses producing the currents affecting the pipes. These current records, by their agreement with the load curves of the trolley road, are frequently also useful in serving as evidence that the currents in the pipes are trolley road currents. As the electrolytic dam-

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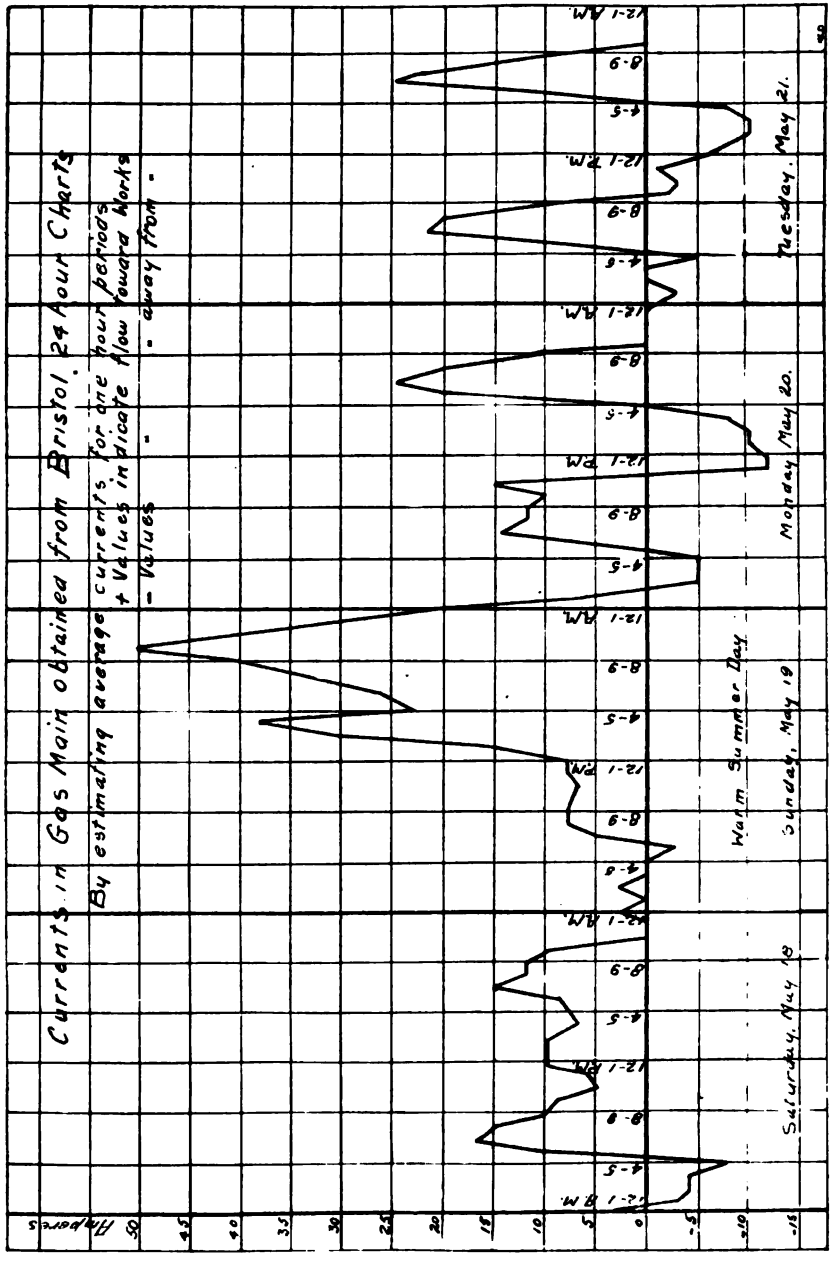
Currents in Gas Main obtained from Bristol. 24 Hour Charts
By estimating average currents for one hour periods
+ Values indicate flow towards Works
- Values - away from -
Warm Summer Day
Saturday, May 19
Sunday, May 19
Monday, May 20.
Tuesday, May 21.

Fig. 4—Record of Current in a Gas Main for Four Consecutive Days.

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age is proportional to the time during which the current acts, it is necessary to have the time curve of current in order to estimate the probable destruction. One ampere leaving an iron pipe for wet soil will remove twenty pounds of iron in one year, but the same ampere of current in its path through the ground and pipes may leave the pipe and return to it any number of times, shunting, for instance, around occasional high resistance joints, and removing iron at the rate of twenty pounds per year at every point of leaving the pipe. The actual damage is also very much dependent upon whether the exit of current is concentrated in a small area or is distributed over a large area. Experience shows that the electrolytic corrosion ordinarily takes place in spots, producing pittings in the pipes, which indicates that the current must leave the pipes in these spots and not from the entire surface; the pipes are in this way much more quickly destroyed than if the corrosion took place uniformly over the entire surface. It therefore is an extremely difficult matter to estimate the amount of electrolytic damage and such estimates will generally be too low for the above reasons.

It is possible to trace the path of current through the ground by measuring potential differences between different points in the ground. An iron rod driven into the ground is often used for making contact for such measurements. This, however, is not reliable because the electromotive force of polarization of the iron in wet ground is dependent upon the surface condition of the iron and upon the ingredients of the ground; it is not constant, and not necessarily the same for each of two rods in different parts of the ground. Where small potential differences are measured between two points in ground by means of iron rods as electrodes, entirely wrong results may be obtained because of difference in the polarization voltages at the two electrodes.

To overcome this difficulty the "non-polarizable electrode" shown in Fig. 5 was devised by Professor Haber. This consists of a glass tube about two inches in diameter and ten inches long, having a porous cup cemented to one end, and containing a saturated solution of zinc sulphate with a zinc rod

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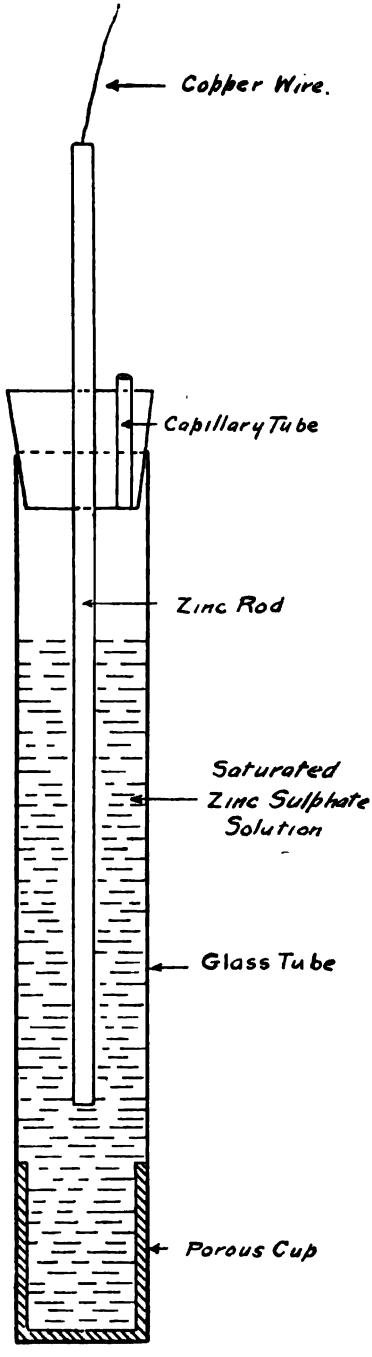

Fig. 5—Non-Polarizable Electrode.

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dipping into the solution. The porous cup is pressed against the part of the ground at which the potential is to be measured, establishing contact between the ground and the zinc sulphate solution. There is only a negligible polarization voltage between the zinc sulphate and ground. The zinc in this solution has a definite and constant polarization voltage with reference to the solution. When two of these electrodes are used to measure the potential difference between two points in the ground, the two polarization voltages balance each other. With these electrodes a zero method, such as a potentiometer with a sensitive galvanometer, should be used for measuring the potential differences, because the high resistance of the contact through the porous cup would produce a drop in voltage and reduce the reading on a direct reading voltmeter. This non-polarizable electrode is also used to measure the potential difference between a pipe or rail and the ground; in this case the polarization voltage of the electrode must be taken into account, which is equal to 0.45 volt negative with reference to the iron of a pipe or rail. This means that without current flowing between pipe and ground the potential difference between an iron pipe in ground and this electrode placed nearby in the ground would be 0.45 volt, the pipe being positive. If, then, a measurement shows the pipe, say, 1.1 volts positive to the electrode it means that the pipe is $1.1 - 0.45 = +0.65$ volt (positive) to the ground and proves that current is flowing from the pipe to the ground. If a measurement shows a pipe, say, 0.15 volts positive to the electrode, it means that this pipe is $0.15 - 0.45 = -0.3$ volt (negative) to the ground and proves that current is flowing from the ground into the pipe. Ground potentials of less than one-tenth volt cannot safely be used as evidence of current flow as they may be due to accidental causes.

It may be desirable to measure directly the flow of current through ground as between a pipe and a rail, or between two pipes. The best arrangement for this is the "earth amperemeter," devised by Professor Haber and illustrated in Fig. 6. This consists of a wooden frame with two copper plates about four inches square and separated by a plate of mica or glass,

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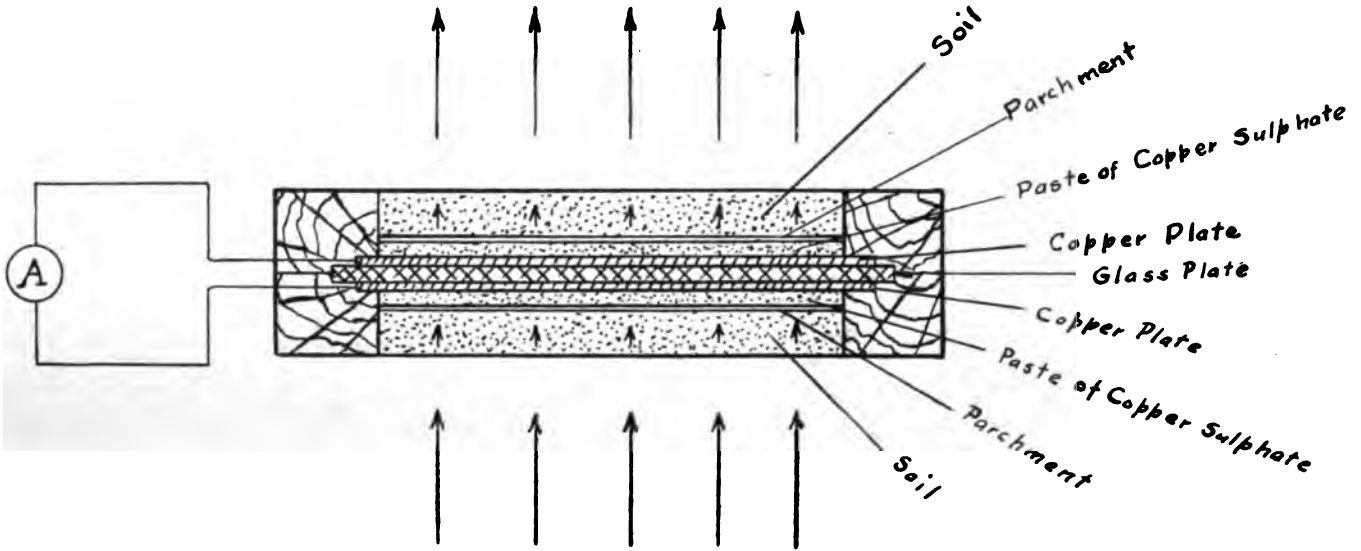

Fig. 6—Earth Amperemeter.

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as shown in the figure. These copper plates are covered with a layer of paste made of copper sulphate and water with 20 per cent. sulphuric acid, the thickness of paste being about $^1/_{16}$ inch. A wetted piece of parchment paper is laid over this paste and the remainder of the frame is filled with soil taken from the portion of ground where the current is to be measured. This frame is then placed in a suitable excavation in the ground where current is to be measured, so that the current flow is as nearly as possible normal to the frame, and the latter is then completely covered up, the soil being tightly tamped in. Insulated copper wires are brought out from the plates and connected with a milli-amperemeter; this will indicate the current flowing through this section of the ground. The object of the copper sulphate paste is to prevent polarization at the surfaces of the copper plates, which otherwise would produce an electromotive force opposing the flow of current through the meter. The direction of the meter indication will give the direction of the current flow through the ground. It might be supposed that the introduction of this frame would entirely change the current conditions in the ground; this has not been found to be the case, due to the fact that the resistance of the path through the ground is very high; the displacement of the small portion of ground taken by the copper plates therefore does not greatly change the total resistance of the path of the current through the ground. The notion that the earth is a conductor of negligible resistance applies only when the path of the current is through an unlimited cross section; the resistance of a limited section of earth is comparatively high, varying under ordinary conditions from 100 to 1,000 ohms between opposite faces of a cubic foot.

This earth amperemeter is well suited for measuring current flow between pipe and ground; for this purpose the frame is buried in the ground from one to two inches from the pipe, and parallel to the pipe and normal to the probable current flow through ground. This measurement can be used to form an estimate of the probable amount of electrolytic damage to the pipe, and in cases where corrosion has taken place it will serve as evidence that it was caused by stray currents.

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I have made a number of laboratory tests with the non-polarizable electrode and the earth amperemeter and have obtained exceedingly satisfactory and consistent results.

I want to call attention to a wholly incorrect method for determining current flow between pipes and rails through ground, which I have seen described in a certain class of electrolysis reports. I refer to the method in which the potential difference between a point in the rails and a point in the pipes is measured with a voltmeter, as between C and D in Fig. 7, and the resistance between these same points is measured with an ohmmeter; the voltage divided by the resistance is given as the current in amperes flowing through the ground. This is then repeated for other points, as E and F, G and H, etc. (Fig. 7), and these currents are added up to give the total current through the ground. In one published report of this class upon a water piping system in a western city, this total current is given as 6,148 amperes with a calculated destruction of 122,960 pounds of iron per year. The following words of warning are found in this report: "The loss of 122,980 pounds of metal per year from the distributing water system must eventually bring great and serious trouble involving the expenditure of many thousand dollars." The absurdity of these figures is clear when we consider that many times this current could have been obtained by making tests in a sufficient number of additional points in the system. Current through ground between pipes and rails cannot be determined from such measurements of potential difference and ground resistance. The latter is the joint resistance of all conducting paths between the entire piping system and the entire rail system, while the potential difference is that between a point in the pipes and a point in the rails; these two measurements can therefore not be combined by Ohm's law to give current, and the figures which have been given in the reports referred to are entirely without meaning; the results and conclusions based upon them are consequently wholly untrue.

As an example of the wholly incorrect conclusions which this method may lead to, I have shown in Fig. 8 the instantaneous values of current measured in a gas pipe at stations

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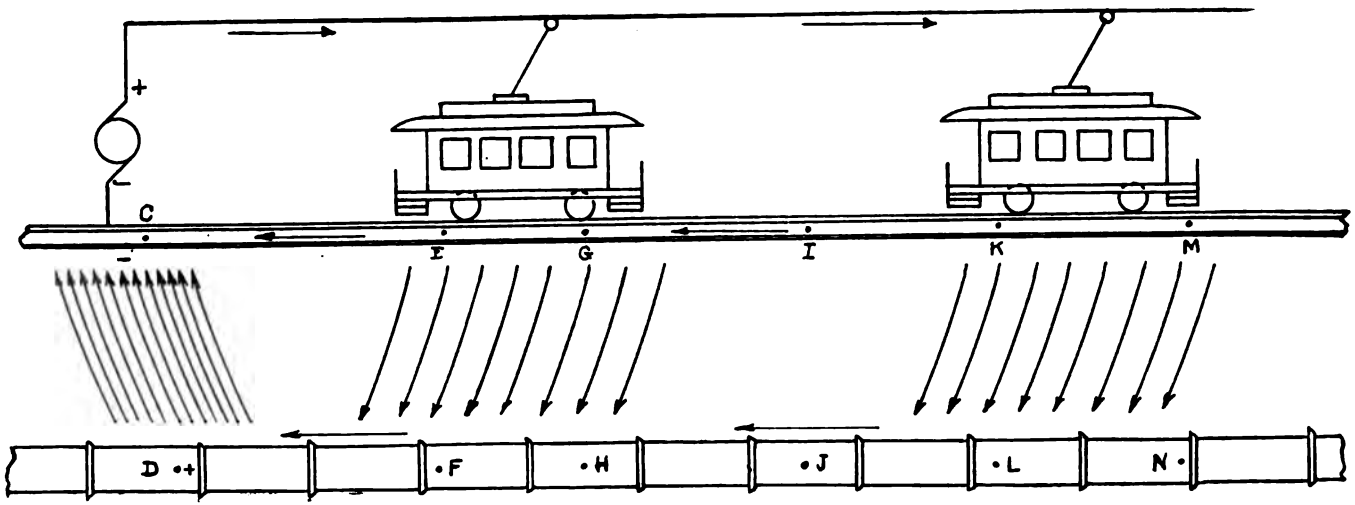

Fig. 7—Diagram Showing Path of Stray Railway Currents.

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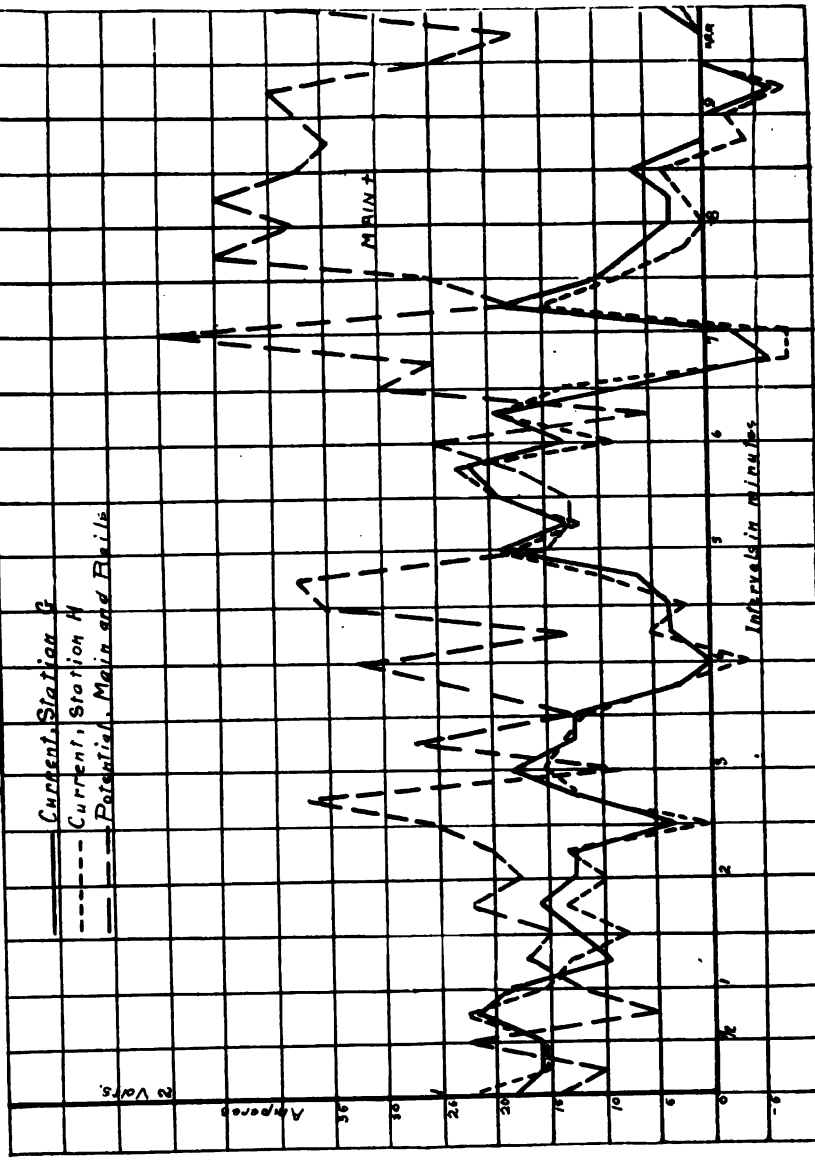

Fig. 8—Simultaneous Readings of Currents in Gas Main and of Potential Differences Between Main and Rails.

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on each side of a stretch of ground soaked with salt water, taken simultaneously with potential readings between this pipe and trolley tracks close by and in contact with this wet ground. The gas pipe is seen to be about one volt (average) positive to the rail. The resistance between the rails and pipe must be very low so that a current calculated by the above method would give a large value and lead to the conclusion that this current was passing from the pipe to the wet ground and producing corrosion. The simultaneous current readings show however that there is practically no escape of current from the pipe between these stations. This class of report is generally also full of remarkable statements which greatly exaggerate the electrolysis danger and which seem to be designed to scare people against the electrolysis evil. From the absurdity which appears on the face of these reports they tend to hide the real electrolytic conditions and the real dangers which exist. The technical press has already exposed and severely criticized some of these reports which have been published.

Where more than one electric road is operating in the vicinity of a piping system, the stray current in the pipes may be the leakage current from one, or it may be the sum of the leakage currents from all of the roads. In cases where electrolytic damage has resulted it is important to trace and prove the source or sources of the destructive current in order that claims for damages and a demand to stop this current may be presented to the proper owners, and pressed in court if necessary. This is fairly simple if it is possible to disconnect each power house in succession for an interval sufficiently long to measure the effect upon the pipe current. If this cannot be done, indirect methods must be used which may make the problem very troublesome, especially in cases where two or more roads use a common track for part of their line. Noting the starting, running and stopping and location of the cars on each line, and comparing this with the current curves in the pipes, will often help to locate the source or sources of the pipe current. Where the tracks of the different roads are independent, a good method is to attempt to measure the cur-

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rent flowing through the ground between pipes and the rails of each system by means of the earth amperemeter. No universal method can, however, be given because the conditions vary so widely; it is necessary to study each case separately and to adopt the methods best suited to it.

Of the attempted remedial schemes the one most frequently applied to pipes in America is bonding in the positive districts to the negative bus bar. While affording local protection, this greatly increases the amount of stray current, frequently producing electrolytic trouble in other portions of the piping system, as at joints, and the pipes themselves become a source of danger to other underground metal. In cases where there are variations in current flow, as was, for instance, illustrated in Fig. 4, no bonding scheme can be applied as the positive zones keep shifting about.

Insulating joints can only be used in special cases to affect a partial reduction in the stray currents in the pipes, and often do more harm than good.

I am convinced that in most cases there is but little, if anything, that the pipe owner can do to protect his pipes from these stray railway currents. The cure must and in all fairness should come from the railways. This is the attitude which the Germans have maintained ever since they have begun to study this problem.

The question of the proper restriction to place upon the railroad in order to render underground piping reasonably safe from stray currents is a hard one to settle. In some places a maximum permissible potential difference in the rails, or between rails and pipes, has been prescribed. The amount of stray current depends, however, just as much upon soil resistance as upon potential difference, and this resistance varies so largely that no maximum safe voltage can be prescribed for all cases, except one so low as to be entirely impracticable. The maximum allowable current in any one pipe is sometimes prescribed; this, however, is also inadequate. The only really safe condition would be a maximum allowable density of current leaving any one pipe for ground, expressed in milliamperes per square foot of pipe surface. This is, however, trou-

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blesome to measure, and the restriction would be very difficult to enforce.

THE PRESIDENT: We will now have a little diversion in the form of the report of the Committee on Electrolysis. Mr. Glasgow.

A MEMBER: Mr. President, we have just listened to a very interesting and able paper on this subject, and before Mr. Glasgow makes his report for the Committee on Electrolysis, I move that a most hearty vote of thanks be extended to Professor Ganz.

Motion seconded.

THE PRESIDENT: Gentlemen, you have heard the motion that a most hearty vote of thanks be extended.

A MEMBER: A rising vote, Mr. President.

THE PRESIDENT: A rising vote is called for. All those in favor will please arise. It is a unanimous vote.

PROFESSOR GANZ: Mr. Chairman and Gentlemen: I thank you most heartily for this vote.

REPORT OF COMMITTEE ON ELECTROLYSIS.

MR. A. G. GLASGOW: Mr. President and Gentlemen: I asked Mr. Clark to call for the Report of the Electrolysis Committee as soon as Professor Ganz had finished his lecture, because this lecture is, in fact, the report of your committee for this present year. You must not fear that every year we shall inflict upon you an annual report like that of 1906—of some 173 pages. On the contrary, we shall trouble you with a report only when we have something to say. We think you will all now agree that if your committee has done nothing else to justify its existence it has done yeoman's service to this Institute in securing Professor Ganz as its consulting engineer and in starting him in the electrolysis business.

I should like anyone who has any suggestion or criticism to offer to state it freely now, while Professor Ganz is still with us; he will be happy to answer any questions or meet any

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criticism that the individual members of this Institute may wish to offer.

I may add that our relations with the chairman of the German Gas and Water Association continue very cordial. We are not blessed as they are with a considerable annual appropriation for investigations into electrolysis, but we are generously allowed the benefit of their conclusions; and we have recently entered into correspondence with the French and British Institutes looking to the appointment of co-operative committees by those two institutions. Manifestly, if the Gas Institute of this country and these three European sister institutions can all work in concert in this matter it will be far more beneficial than if each one of us works alone.

In conclusion let me say that when we distributed our original report, some six months before the 1906 meeting, we invited communications from the members relative thereto; but not a single communication or suggestion of any sort was made. Now, I submit that a committee of this nature of an Institute of this character has the right to expect that the individual members will take a keen and active interest in the work and communicate any facts or information that will add practical value to the conclusions. If, on the other hand, anybody has been nursing any discontent with our last report, now is the time to ventilate it; for your committee sees nothing to change therein, and at present has nothing to add thereto. We hope, however, that in the reasonably near future we shall be able to substantiate our conclusions to such an extent that we shall feel justified in inviting some undertaking to test them in a court of law with every prospect of success.

MR. E. J. DONAHUE: Mr. President, I move that the Committee on Electrolysis be discharged with the thanks of the Institute.

Motion seconded.

THE PRESIDENT: Is there any discussion on this statement made by Mr. Glasgow?

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MR. A. S. MILLER: Mr. President, I am not going to let my dear friend from "dear old Lunnon" back me down. It has been some time since I read his report, and I do not know whether I remember it correctly or not, but my best recollection is that the conclusion of the committee then was that the only thing to do was to put in a double trolley. Is that it?

MR. GLASGOW: Yes.

MR. A. S. MILLER: That was my best recollection, that they came to the conclusion that the only absolute safety lay in the double trolley. We have to take conditions as we find them. The question that the gas man has had to decide, when he has found stray currents on the pipes, was what to do about it. I have for a number of years advocated bonding, notwithstanding that Professor Ganz of this committee thought that such a remedy was radically wrong, but I have not felt it possible to go into a court of law with the idea of making the railroad reconstruct its whole system when it could for a very small expenditure, comparatively speaking, adopt an efficient remedy by bonding. I did not feel that there was anything for us to do but to bond. When a system of piping is bonded it does not necessarily mean that you must simply tie in a few places of high potential; but you must make a careful survey, as Professor Ganz says, of the whole system to determine the danger points. It is necessary to survey the water pipes, cables and all other underground structures in the neighborhood and to extend the return feeders far enough from the generating or sub-stations to prevent an excessive flow of current through any particular pipe or cable. It is also necessary to bond to the proper returns all of the underground structures in the immediate vicinity. Such underground structures can be bonded so as to practically prevent electrolysis and this has been done in at least two cities to my knowledge. I do not say that the double trolley would not be better, but so far, it has been commercially impossible to compel the railroad companies to change to the double trolley system.

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MR. DONALD MCDONALD (Louisville): Mr. President, I am sorry to hear that statement made before this Institute, because if anyone of you ever has a lawsuit with a street railroad, Mr. Miller's remarks will be read verbatim to the jury as showing that this difficulty with electrolysis can be overcome by bonding. We had that out pretty thoroughly last year, and it was the opinion of this whole association that as soon as the stray currents were turned loose there was bound to be mischief, and that there was nothing that the gas company could do to protect itself. I think the fact is that you can, to some extent, localize or minimize the trouble by the bonding that Mr. Miller advocates, but in the case of cast iron pipe with lead joints or at some of the fittings in wrought iron screw pipe, you are bound to have trouble wherever the current leaves the pipe or leaps across any gap in the continuous conductor.

MR. H. L. DOHERTY: In common with Mr. McDonald, I am sorry to see anything go on the record here which is going to aggravate the trouble in any way. I do not want to make any remarks myself, but I do not think that the double trolley is necessary in most cities, and yet I do believe there are conditions where it is almost imperative. I did not read last year the report of the Committee on Electrolysis, and I was not present when it was discussed, but I have listened to the lecture by Professor Ganz with a great deal of interest, and, personally, I want to pay tribute to his ability on this subject. I think he discloses some rather startling errors that have cost the water and gas companies of this country a great deal of money and a great deal of trouble. Personally, I do not think there is any general rule that can be laid down regarding how a system should be arranged to prevent electrolytical action, but I know I have tried to get some sort of a rule to go by, and the only rule that I ever evolved was one that sounded so simple that it seemed almost foolish, yet I believe that rule has saved us a great deal of money and has helped to do our work properly. That rule is simply *that the arrangement must be such as to prevent the current from leaving the pipe through an electrolyte.* If you plan what you are going to do, and if

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you will measure it by that rule, you will find that you have produced the condition that you want.

Professor Ganz's remarks on the need of simultaneous observations is another thing which I think will bear reiteration. The measurements that are made by one group of observers at different hours of the day, upon different days, and under different conditions of soil, I think sometimes are apt to be so misleading that you are worse off with them than if you did not have them at all. Now there has been a general feeling that bonding was the proper thing to do, but at the same time it always seemed to me that bonding at the power house would tend to generalize your trouble rather than to localize it, and if I must have electrolytic action I prefer to have all of that action take place at one spot, if possible, where I can anticipate the trouble.

There were several other points in Professor Ganz's lecture which I think we can well afford to lay great emphasis on. One is the difference in potential. While he made it very clear that there is no such thing as being able to determine the action by the difference in electromotive force, I still think that that particular point, in view of the common error that prevails, should be more definitely emphasized. It is the point where you get the small difference of potential where your trouble is apt to occur. It is also the belief of most gas men that the most perfect system of bonding on the part of a street railway company would be the most perfect protection, but there are often cases where bad bonding at certain portions would be advantageous. I might cite an example of a line going out through dry soil, perfectly dry soil, and then going through a swamp, and going into another portion of dry soil. Now, if you destroy the railway company's bond at the point of leaving the dry ground and go into the swamp and depend on all the current going to your pipe in the damp ground at that point, and going off through the metallic bond at some other point, you would very likely be free from electrolytic action from that particular current. In general, I believe that bonding of pipes to rails is about the most dangerous thing

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that can be done, but when it is going to be done, it ought to be done by a man who thoroughly understands the problem.

Outside probably of the work which has been done by our Committee on Electrolysis, and I wish, so far as that is concerned, to express my admiration for Mr. Glasgow and the Committee, I think it would be a good thing for the gas men of the country if all the previous literature that I have seen on this subject, with the exception of the address of Mr. Bump before the Western Association, was burned up.

MR. MILAN R. BUMP: Mr. President, if I may add a few words to this discussion. I think the man who advocates a system of insulated joints has been somewhat neglected, though the derivation of benefit therefrom is nearly always considerable if they are intelligently installed. We have gas men who say that they do not care whether the water company goes ahead and bonds or not. I have heard that statement made. Now it is a well-known fact that there is a constant interchange of current between the water pipes and gas mains. Take the ordinary system with a thousand or more water heaters, where we have got a metallic connection between the two systems and it is apparent that what one does must affect the other even if there were no interchange of current through the earth.

Recently there is another factor which has entered into this problem, and that is the adoption of the alternating current system for traction work, which I believe is going to be the ultimate solution. The progress of this system will be slow in the large cities, but it is already coming in, and will progress more in the cities in the future. I believe that the solution of our trouble will lie in the adoption of some such system as that. Bearing on that question of the electrolytic effect of alternating current on the pipes, there was a paper presented before the American Institute of Electrical Engineers, in which it was proven that the damage by electrolysis is reduced to a fraction of a per cent., which makes the damage so small that it would be almost impossible to distinguish between it and natural corrosion.

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MR. H. L. DOHERTY: Mr. President, before you close this discussion, I would like to add just one word by stating that what we want, as it seems to me, is a practical check valve for electricity, so that when we make a bond we will not only make a bond that will take the current off the pipes but we will make a bond that will not take it on. What we want is a practical commercial check valve that will allow the current to go off the pipe, but not let it go on. I have felt that the bonding of a street railway system where we had an immense number of water connections was apt to be an advantage to us, although I would defer to Mr. Bump's judgment on that. Where the water company has thoroughly bonded its system, and we have a number of metallic conductors, the action in a city where they use cement joints would be that any current entering our pipes would be apt to go back and take a path on the water main.

PROFESSOR GANZ: I have just jotted down a few notes.

In regard to the significance of potential differences as an indication of electrolysis or of current, I agree thoroughly with what has been said. I think that is also borne out in my written lecture, and perhaps better than in what I have said this afternoon. I think some one has also said that the two cities to which Mr. Miller referred were bonded by him. That is probably why they have developed little trouble. I cannot deny that if you run a large return conductor from the negative bus bar to every positive pipe of your system, and maintain every pipe negative, that then the system will be safe. If, however, you have a condition such as I showed on the board this afternoon, or such as I have here in the diagram, where four times during the day the current at one point in the system changes in direction, then the points at which the bonds would have to be applied would also change, so that it would be practically impossible to bond successfully.

It was also said that the solution of the problem will be the use of alternating current. I do not think that this is necessarily so. I agree that laboratory experiments have been conducted which show that with alternating current the electrolysis

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is only up to two per cent. of that produced by an equivalent direct current, but we have no practical experience with alternating current roads. Alternating current will produce electrolysis, not only where the current leaves the pipe, but where it enters the pipe, and I am not so sure that a piping system is going to be safe even if alternating current should be adopted for all neighboring electric roads; this is still a long way off.

I think that is all I care to say.

THE PRESIDENT: There is a motion before the house. It has been moved and seconded that the Committee on Electrolysis be discharged with thanks, and that the whole matter be referred to the Technical Committee. Are you ready for the question? Those in favor say "Aye." Contrary minds, "No." The motion is passed.

The time for adjournment is passed, and we will take up the first thing in the morning whatever committee reports have not yet received attention.

The convention will now stand adjourned until ten o'clock to-morrow morning.

The Institute adjourned to 10 A. M., Friday, October 18.

THIRD DAY—MORNING SESSION.

The Institute was called to order at ten A. M., President Walton Clark in the chair.

THE PRESIDENT: The time for opening the meeting has come. I am sorry to see so few members present, but it is necessary that we proceed with our business. We still have a great deal to do.

The Chair has two committees to name under authority of the Constitution. On the Public Relations Committee the Chair has done what some may criticize in putting his own name on the list of members of that committee.

DR. A. C. HUMPHREYS: Gentlemen, I will explain that fully: This committee will have to do a great deal of work, and I

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particularly requested the President that he put himself on that committee. The President is familiar with a great many of the matters which necessarily will come before that committee, and I think it is essential that he should be a member of it.

THE PRESIDENT: On the Public Relations Committee I have appointed Mr. E. G. Cowdery, Chairman; Mr. I. C. Copley, Mr. C. F. Prichard, Mr. John Gribbel, Mr. Donald McDonald of Louisville, and Mr. Walton Clark.

On the Technical Committee, Mr. W. H. Gartley, Chairman; Mr. Alten S. Miller, Mr. W. A. Baehr, Mr. W. E. McKay, Mr. R. B. Brown, and Mr. A. G. Glasgow.

The next business in order is the report of the Committee on "Economic Balance between Calorific Value and Candle-Power," Mr. T. D. Miller, Chairman.

A MEMBER: Mr. President, I understood that the Committee had decided to make no report.

THE PRESIDENT: Then the next is the report of the Committe on "Bureau of Information," by Mr. Gartley.

MR. W. H. GARTLEY: I have a report for the Committee which can be turned in. I will read the questions, there are only eight, because the questions will give you some idea of the scope of the Bureau's work as so far conducted, and allow you to judge whether it is better to continue the work or not.

REPORT OF THE BUREAU OF INFORMATION.

The Bureau of Information, having received notice of their appointment on April 22, 1907, wish to report that up to September 30, 1907, eight questions (the eighth's answer not yet prepared) have been referred to them. These questions show a tendency towards the elementary facts connected with the gas business.

It is apparent that the members of the American Gas Institute are slow to avail themselves of this source of information, but it is believed by the Bureau that, judging from the nature of the questions submitted, it would be worth while to

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continue the experiment of operating such a Bureau for at least a year longer.

In compiling the answers to the questions submitted, the members of the Bureau believe that before the answer is sent to the inquirer, it should be passed upon by every member, and that in order to save time the Chairman of the Bureau should receive the question direct from the inquirer, instead of having it sent to the Secretary of the Institute.

The inquirer should not expect to receive a fully considered reply within a month or six weeks from the date of the question.

The Bureau recommends that the questions (the name of the questioner being withheld) with their answers be published in the Proceedings, but that the Bureau exercise its discretion as to omitting any answer that partakes of a personal or advertising nature.

Question No. 1: We are operating a small gas plant and send out about 35,000 cu. ft. daily and are experiencing great difficulty from naphthalene at a point about 700 feet from our works. The plant is located at a point about 20 feet lower than the main where the difficulty occurs. We have been removing the naphthalene by naphtha. The main is 8 inch.

Kindly inform me the best manner of thoroughly cleaning the pipe at that point.

Answer: From the above it is supposed that your trouble is a recurring one, which means that you are still making naphthalene at the works, in which case any temporary remedy will only give temporary results. It would, therefore, be advisable to take such steps as will eliminate the sending out of naphthalene from the works.

In order to clear the main at present, I would suggest that you take pressures with a water gauge at points from 100 to 200 feet apart, and determine just where the largest drop in pressure occurs. This point would indicate the greatest stoppage. At the first opening from the works inject into the main 87° gasoline at the rate of about one-half pint per thousand cubic feet of gas during the period of peak load. Repeat

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this procedure until the pressure gauges show no abnormal drop in pressure.

Eighty-seven degree gasolene is very volatile and must be used with the utmost care and should be used only by experienced men. If these are not available, it would be better to use a lower grade or a less volatile gasolene. The solvent may also be introduced immediately after the street main governor, but it is safest to use it in the open air.

For further information on this subject, please see Question Box of the Ohio Gas Light Association for 1905, pages 111, 184, 201, 208, 209, 270 and 293.

Also see paper on "Prevention of Naphthalene Stoppages," by Mr. Paul Doty, before the Western Gas Light Association, in American Gas Light Journal of June 26, 1899, page 967.

Any hydrocarbon oil, alcohol and some others, are solvents for naphthalene. Some of these will add to and others take from the illuminating value of the gas.

Some manufacturers prepare an oil called "Naphthalene Solvent," containing a mixture that will not affect the gas. Any oil used, of course, should be free from naphthalene.

Question No. 2: Can gas coal shipped from the Pittsburg region be stored out of doors without danger of spontaneous combustion in piles twenty feet high? If it is not considered safe to store it in piles of this height, would the danger of spontaneous combustion be eliminated if the coal was roofed?

Answer: Spontaneous combustion in coal from the Pittsburg region piled in piles twenty feet high, out of doors, is extremely unlikely to occur, but it has occurred. It has also occurred when piled in sheds.

References:

Fire Risks and Fire Extinction.

The Spontaneous Ignition of Coal.

London Journal of Gas Lighting, April 3, 1906, page 33.

Question Box, New England Association of Gas Engineers. American Gas Light Journal of March 7, 1904.

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Ohio Gas Association, Question Box, 1905, pages 10 and 11.

Proceedings of The American Gas Institute, Vol. 1, 1906, Practical Class, section of 1909, pages 264, 265, 266.

Journal of Gas Lighting, March, 1900, address of President; Southern District of Gas Engineers and Managers.

American Gas Light Journal, Dec. 18, 1899, page 977; "The Combustibility of Coals," by Mr. O. Lang.

Journal of Gas Lighting, January 1, 1901, page 26. Short note on some causes of spontaneous combustion of coal.

Question No. 3: We are considering the advisability of furnishing an adjoining town with high pressure gas. It is eight miles away and is divided into three small villages. Our gas mains would parallel an electric road all the way. The population of the district is about 4,000. We estimate that we can get 500 customers in five years. The price of gas to start with will be $1.25 net. The estimated maximum hourly consumption will not exceed 3,000 cu. ft. in three years and 4,000 cu. ft. in five years.

a. What size pipe had we better run?
b. How deep should this pipe be laid?
c. Should this pipe be laid with or without insulating joints, and if with insulating joints, how often?
d. Is it better to distribute by district governors to low pressure mains in the three villages, or by high pressure only?
e. At the generating plant, is it better to put in two Westinghouse Air Compressors with governors for automatic action between certain limits of pressure, or horizontal Rand Compressors in duplicate, same governor arrangement?
f. To how many pounds can I compress without reducing the candle-power? I make ¾ coal gas and ¼ water gas.

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Answer: a. What size pipe had we better run?

Reference should be made to answers to questions d and f, covering initial and final pressures on this proposed pipe line. The Pittsburg formula for high pressure transmission will be found satisfactory in determining the amount of gas that will be transmitted through any size of pipe constituting this pipe line and between the pressures determined upon.

It is not stated whether there will be any further expansion of business after five years, or whether there is any possibility of a further extension of this pipe line.

With the facts given, the minimum size sufficient for this installation is 2½ in., with which size pipe this pipe line will supply 4,000 cu. ft. per hour with an initial pressure of 20 lbs. gauge and a final pressure of 10 lbs. gauge. At 30 lbs. initial pressure it will supply 6,000 cu. ft. per hour. If this can be considered satisfactory it will be advisable to install a compression storage tank of moderate capacity at the end of this pipe line and as near the centre of the distributing system as possible, in order to steady the pumping conditions which will otherwise be irregular with a line of such small storage capacity, and to safeguard the gas supply during any repairs which may hereafter become necessary on this pipe line. It may also be borne in mind that this storage at the end of the line will increase the peak load delivery capacity of the line. This pipe line so equipped will be found entirely satisfactory.

If there be other conditions, however, with regard to which the next larger size of pipe may be considered advisable at a greater investment cost, storage at the end of the line may be dispensed with for a time at least. The cost of the compression tank may be roughly estimated at $500.00 which is here stated in order to facilitate the estimate by the inquirer as to the relative cost of these two pipe lines. There will be practically no difference in pumping cost as between the two sizes.

b. How deep should this pipe be laid?

This pipe should be laid with the top of the pipe from 2 feet 6 inches to 3 feet below the surface of the ground.

c. Should this pipe be laid with or without insulating joints, and if with insulating joints, how often?

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There is much difference of opinion among engineers as to the value of the insulating joints on pipe lines laid in the ground. It is clear that they will diminish the amount of electricity flowing in a pipe only when the electric current cannot jump through the ground around the joints, and that in case of such leakage they are a source of danger. Following the satisfactory experience on a line that has been in for many years and which similarly parallels an electric traction line, it is rather suggested for safeguarding this proposed line that it be laid ten feet or more, if possible, from the nearest street car rail; that wherever it may cross under the rails it be protected under the rails and for at least ten feet on each side of the rails by enclosing it in a box filled with pitch or other non-conducting material; that wherever the distributing mains and services supplied by it cross under the street railway track they be insulated in the same manner. Under these conditions electric currents should not be found on this pipe, unless the soil conditions are extremely favorable to them. In case they are found on this line even after such precautions, insulating joints may be put in gradually, beginning with one at each end of the pipe line, the pipe to be insulated from the ground for a considerable distance on each side of the joint. Surveys following each addition will determine whether or not the joints are of value and how many must finally be placed in the line under these conditions.

d. Is it better to distribute by district governors to low pressure mains in the three villages or by high pressure only?

A consideration of the formula for high pressure transmission will serve to show that for a given transmission line and given delivery of gas, any increase in initial pressure develops a much more considerable increase in terminal pressure. If a given line is delivering gas at a terminal pressure of two to five pounds gauge pressure, it can be made to deliver the same amount of gas at from five to ten pounds pressure by very slightly increasing the initial pressure. It follows, therefore, that direct high pressure distribution entails no increase in the size of the transmission lines, and practically no increase in the pumping cost. On the other hand, there is a very great

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saving between the cost of a high pressure distributing system and that of a low pressure distributing system. The question is wholly, therefore, one of safety and satisfaction. With the ordinary small country towns there can be no question as to the safety of a high pressure distributing system as far as the underground mains and services are concerned, while for any community there is to-day no question as to the safety and satisfaction of a high pressure distributing system as far as the supply to any individual consumer is concerned. In this particular case, a high pressure distributing system is recommended.

e. At the generating plant, is it better to put in two Westinghouse Air Compressors with governors for automatic action between certain limits of pressure, or horizontal Rand Compressors in duplicate, same governor arrangement?

The proper compressor for this installation is the simple straight line compressor with fly wheel. There are several good makes of this style of compressor.

The value of automatic devices is a question on which opinions differ, and on which an answer must be largely a matter of personal opinion. In this class of devices are included whistles and other alarms on boilers, etc. Many engineers do not believe in devices of this nature on which men come to depend and which, some day, may fail in action. If such a device, however, is desired, a bell alarm will probably be found most satisfactory, as giving notice in all cases to the man in charge of the plant when the compressor man has failed in his duty. A recording pressure gauge should be maintained at both ends of the line as a continual check on the pressure carried.

f. To how many pounds can I compress without reducing the candle-power? I make ¾ coal gas and ¼ water gas.

Compression cannot probably be carried beyond five pounds gauge pressure, without some effect on the candle-power, as measured by the photometer. A gauge pressure of 20 lbs., however, will affect no practical impairment of this gas in value to the consumer and occasional pressures of 30 lbs. will likewise not be of moment to the consumer. Up to 30 lbs. gauge pressure this gas, as burned in Welsbach mantles, will not, as

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far as the facts are known at present, be impaired at all in efficiency, and this naturally includes all fuel consumption.

Question No. 4. Can you inform me what is the most practicable and inexpensive blast for laboratory use where water pressure and gas are accessible?

Answer. The most inexpensive and all-round satisfactory blast for laboratory use is probably the one devised by Professor Richards, of the Massachusetts Institute of Technology, and which consists of a suction pump, the outlet of which is connected to a receiver which serves to separate the air from the water and deliver the air under pressure. This apparatus is listed by Messrs. Eimer & Amend, of Eighteenth street and Third avenue, New York, N. Y., and Bausch & Lomb Optical Company, of Rochester, N. Y., and is quoted at about $6.50 complete. To increase the volume of the blast two or more suction pumps can be connected to the separating cylinders.

This apparatus can be easily rigged up by any ordinary gas fitter, and I attach a sketch showing the general arrangement and dimensions of such an apparatus.

Question 5. What is the chief reason for the common practice in gas holder building of having both an inlet and an outlet pipe, or is there any objection to operating a gas plant with the holder and main system in parallel?

Answer. There are four reasons for having both an inlet and outlet pipe.

1st. To average the candle-power of the gas sent out to the consumer. Except in the larger works, the candle-power of the gas as made fluctuates throughout the hour. If the holder holds the make of several hours, a candle-power of a better average is sent to the consumer.

2d. To permit the gas to cool before going to the governor, thereby preventing the heavy deposits of drip oil and water, particularly in the winter time.

3d. To permit the gas coming to nearly a quiescent state in the holder and permit the dropping out of the gas in that condition of certain mixtures of heavy hydrocarbons and tar,

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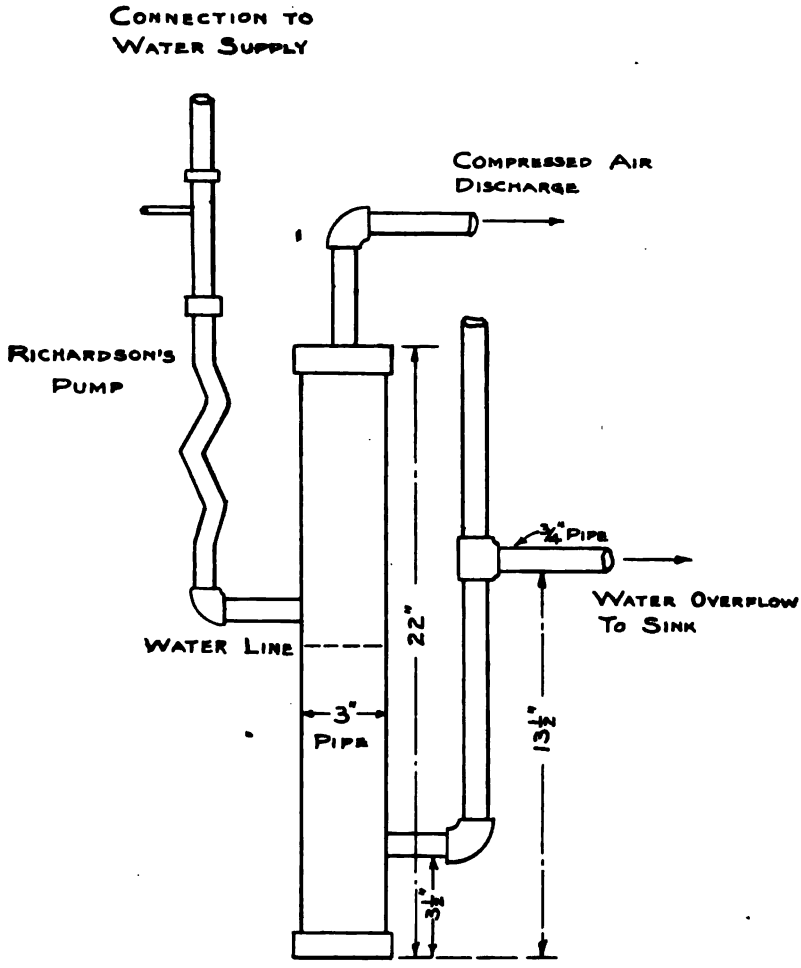

SKETCH OF LABORATORY AIR BLAST

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which, if deposited in the mains at low temperatures, would seriously influence the candle-power.

4th. To insure against the putting of the holder out of commission by reason of one pipe being stopped up with naphthalene or leakage.

Question No. 6. In accordance with the decision of the Bureau, as expressed above in this report, this question and answer has been omitted.

Question No. 7. Can you give me explicit directions (or refer me to some article that will) for finishing off brass goods in the rich gilt finish as seen on the best grade of gas and electric fixtures?

Answer. The best class of gas and electric fixtures are first polished on a buffing machine and then dipped in a preparation of lacquer, for the purpose of preventing the fixtures from becoming tarnished by sulphur and other compounds. The use of lacquer on gas fixtures also permits the fixtures to be cleaned with soapsuds. The common grade of fixtures are only polished on a buffing machine.

Question No. 8. As yet unanswered.

MR. W. H. GARTLEY: Question 6 asked where inquirers could purchase certain forms of fixtures, and it is to be answered, but is not incorporated in the report. That is one of the questions which the committee did not think should be published in the report, as it might work some injustice to manufacturers or houses that furnish material who might have been overlooked by members of the committee whose business it was to answer the question.

The answer to No. 8 is not here, as the answer has not been criticised by all the members of the committee. It is a much more complicated question than some of you may think.

THE PRESIDENT: Gentlemen, the report of the Bureau of Information is before you. What disposition will be made of it?

MR. A. E. FORSTALL: Mr. President, I move that the report of the Bureau be received, published in the Proceedings

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of the Institute, and that the committee be discharged with thanks, and that the matter of the continuation of the work be referred to the Technical Committee.

Motion seconded.

THE PRESIDENT: Gentlemen, you hear Mr. Forstall's motion, which has been seconded. All in favor say "Aye." Contrary minds, "No." It is so ordered. It will be referred to the Technical Committee.

The next business is the report of the Board of Revision of the Question Box on "Manufacture of Gas."

Mr. J. D. Shattuck then presented the

REPORT OF BOARD OF REVISION OF THE QUESTION BOX ON MANUFACTURE OF GAS.

Mr. President and Gentlemen: Your committee took the several Question Box publications of the Ohio Gas Light Association and classified and reshaped these answers, supplementing them with additional matter gathered from the American Gas Light Association's practical class questions, and some other sources of information. We had this work completed about the middle of September when we received a large package from Dr. Harrop, of Rio Janeiro, containing a large amount of matter on this subject. This matter was too valuable to be neglected, and we are now engaged in incorporating this matter and re-arranging what we had already done, hoping to have it completed in time to have it published in this year's Proceedings.

We recommend that the work we have done be published and bound in a similar manner to the work on "Distribution of Gas," and a copy mailed to every member of the Institute, provided our work is not completed in time to go into the Proceedings. If it is completed in time, extra copies to be furnished by the Secretary upon request.

The report is signed by the Committee:

J. D. SHATTUCK,
Chairman;
J. B. KLUMPP,
C. S. LOMAX,
F. W. STONE.

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THE PRESIDENT: That is the whole of the report. Gentlemen, you have heard the report of the Board of Revision of the Question Box on the Manufacture of Gas. What disposition will you make of it?

MR. F. N. MORTON: I move that the committee be discharged with thanks, and that the Board of Directors be authorized at this time to publish it with the forthcoming volume of Proceedings, and if this is not possible, that the Board be authorized, if they see fit, to publish the report in a separate volume, one copy to be sent to every member, and a supply of copies to be sold at a price to be fixed by the Board, and that the matter of further revision of the Question Box be referred to the Technical Committee.

MR. WALTON FORSTALL: I think before that motion is put we should have an expression of the obligation which we are under to this committee, for they really stepped into the breach when it was found that the old Board of Revision, owing to the absence of Dr. Harrop, would not be in shape to go on with the work, and some one was needed to carry it on. It did not seem right that the work should be dropped altogether. I think that especial mention should be made of Mr. Stone, because he had done a great deal of work on this committee, after having earned a rest by reason of his labors on the Distribution section, published last year.

THE PRESIDENT: Is there any further discussion of the matter? Is there a second to the motion which was just made?

Motion seconded.

THE PRESIDENT: Those in favor of the motion will please say "Aye." Contrary minds, "No." Carried.

MR. FREDERICK W. STONE: Mr. President, before you pass that, I would like to make a statement. The committee in making up the report of the Board of Revision last year stated in the report that wrought iron pipe was much superior to steel, that it could be worked easier, etc. Investigations conducted by the committee since then lead them to think, or to

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believe, that the statement as made works an injustice, and we would like to suggest that the matter should be more fully investigated before a definite conclusion is reached.

THE PRESIDENT: You make that statement, Mr. Stone, with the idea that it should be given to the chairman of the Technical Committee for his guidance at the time of making up the sub-committee on the Board of Revision of the Question Box.

The next business in order is the paper on "Air Blast Gas Appliances," by Mr. W. K. Eavenson. We also have one on the program by Mr. W. H. Allen.

AIR BLAST GAS APPLIANCES.

BY W. K. EAVENSON, PHILADELPHIA, PA.

DEFINITION.

This paper deals exclusively with that type of appliance with which illuminating gas is used with air pressure. Air under positive pressure of from one to two pounds is indispensable in this system of combustion.

MAKERS.

A Gas Furnace Company, of New York city, went into the subject of air blast gas appliances some twenty-five years ago. They first perfected a burner that could be used under pressure, then, finding out just the kind of work a consumer wanted to do, built a furnace or machine to do that work. Undoubtedly it was not long before they were called upon to make a burner that could be kept lit in the open under pressure, and their brazing burners, soft metal burners, ribbon burners, and the Machlet tip and a few others are the results.

Makers of Air Blast Gas Appliances whose names have come to my attention are: The American Gas Furnace Company, of 24 John street, New York city; The Chicago Flexible Shaft Company, of Chicago; James H. Walker, Milwaukee, Wis.; Albany Foundry Company, Albany, New York; Leiman Brothers, 139-143 Centre street, New York city.

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GUIDES TO PURCHASING.

In order to guide the purchaser, the Gas Furnace Company have adopted the encircled figure method of cataloguing their products. The encircled figure in connection with a blower represents the air supplying capacity of that blower in terms of a unit of value, based upon the passing capacity, at one pound loss in pressure, of an orifice having an area equal to that of a square whose sides are one-eighth inch. In connection with an appliance, the encircled figure represents the air consumption of that particular appliance in terms of the same unit. For example, if the encircled figure of a blower is given as 33, and that of a furnace as 10, we know that the blower will supply three such furnaces with a margin to spare.

CONSTRUCTION OF AIR INJECTOR.

In the different types of burners described below, the gas and air are mixed by an injector as shown by Figure 1. The air nozzle is soldered on the service ell "A" and extends in the tee "B," slightly beyond the centre line of the side outlet, carrying the air past the gas way, the air creating a slight suction on the gas line. The air and gas are mixed in the pipe "C" on the way to the burner. The air nozzle is made of tin and can easily be replaced by another of different diameter, if adjustment is needed. Satisfactory results cannot be obtained by attempting to ram or contract the nozzle. The air nozzle should be so adjusted as to derive the full benefit of the injector effect. For instance, after the fire brick linings have become sufficiently heated to bring a furnace to its maximum heat, when the lever-handle air cock is wide open, a reducing or gas flame should issue from the furnace vent. The pressure in the gas pipe need not be more than 20 tenths.

VARIOUS FORMS OF BURNERS.

Some types of burners used are described below. In these burners no outside or secondary air is required for complete combustion, and as a rule, any furnace will give better results if it is closed tight at the bottom.

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METHOD OF CONNECTION FOR BLAST FURNACES.

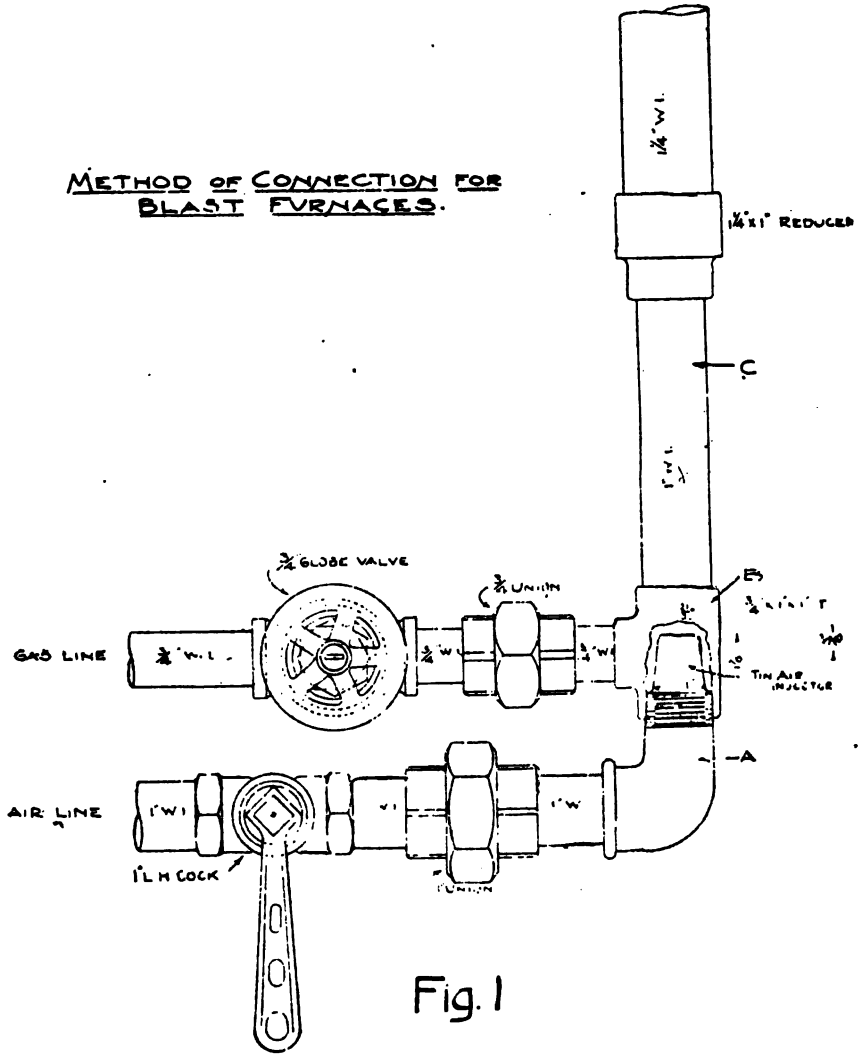

Fig. 1

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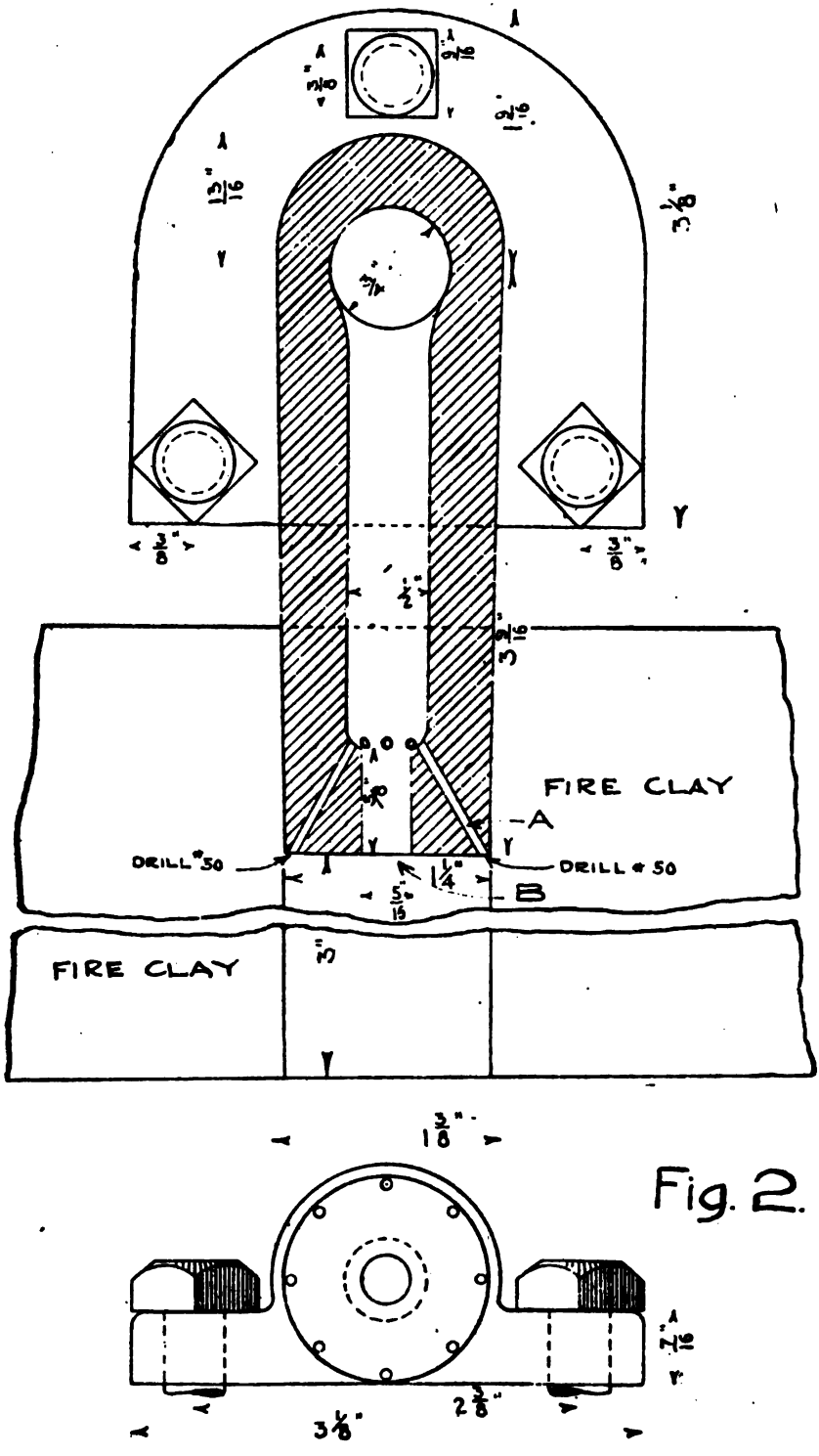

Fig. 2.

BURNER USED IN NO 1 OVEN FURNACE

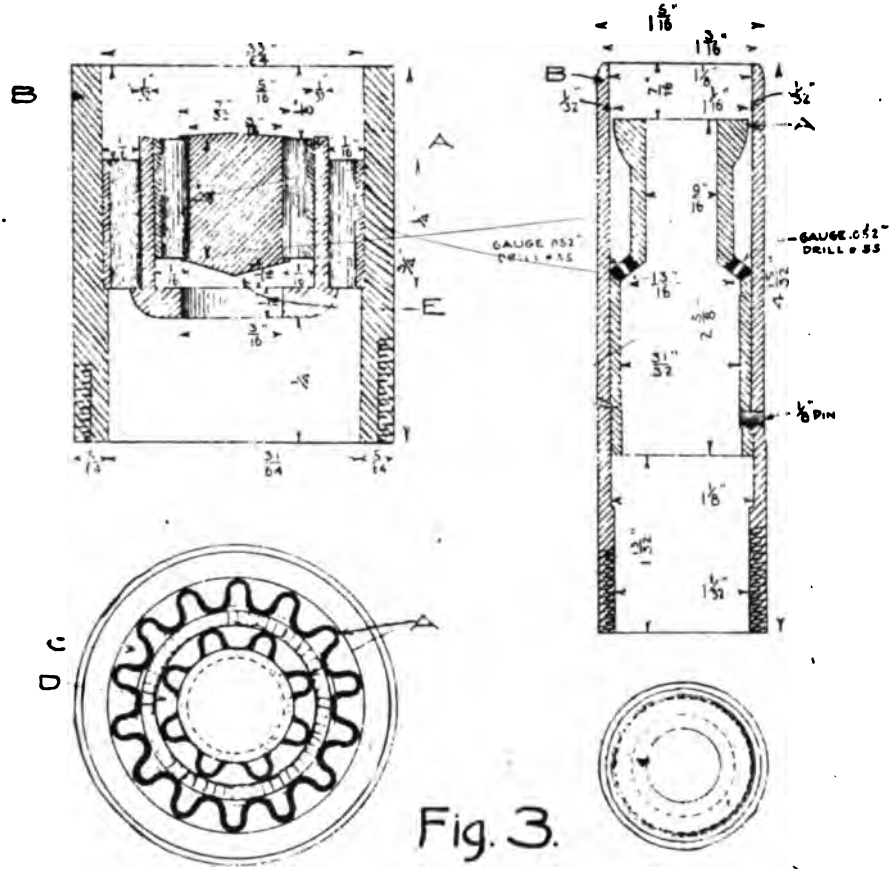

Fig. 3.

MACHLET BURNER TIP
SCALE:- 4" = 1"

FERROFIX BRAZING HEAD
SCALE, - FULL SIZE.

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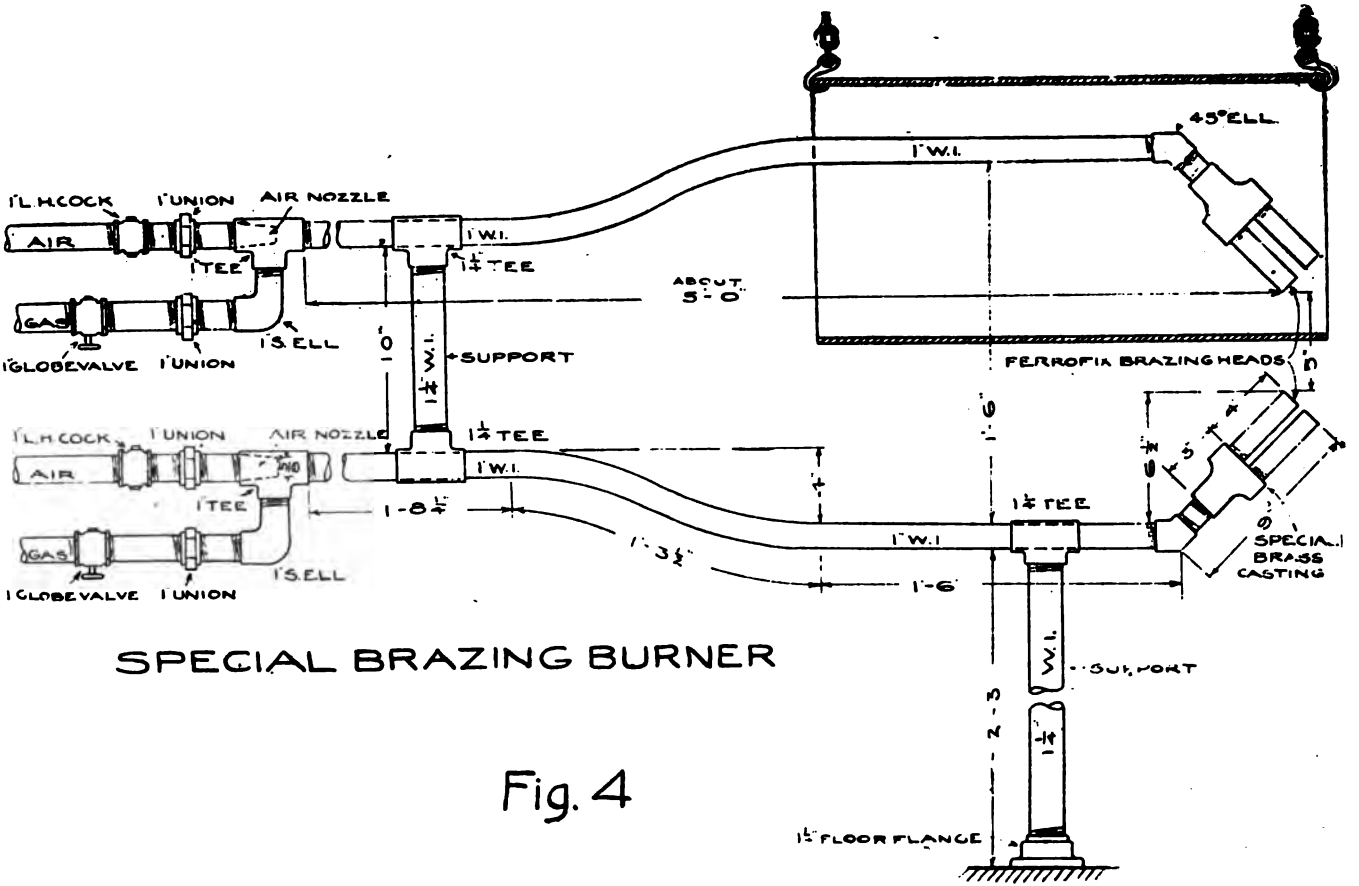

SPECIAL BRAZING BURNER

Fig. 4

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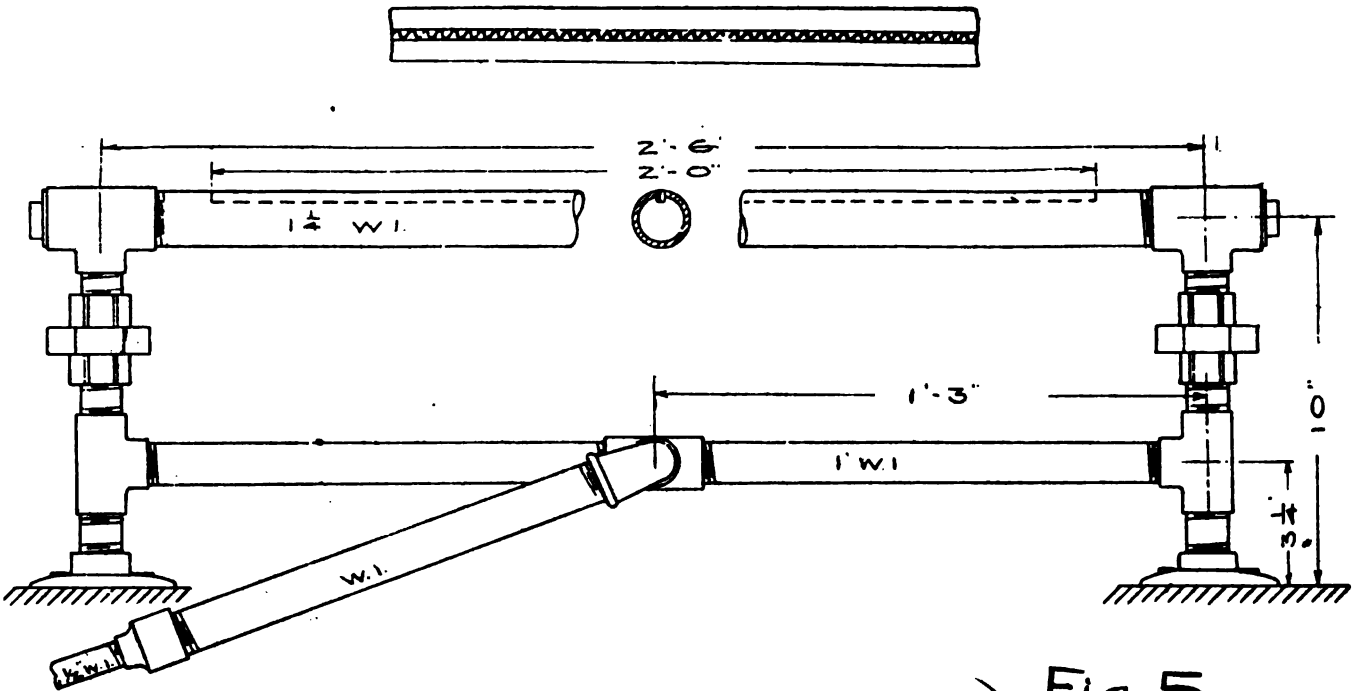

Fig. 5.

RIBBON BURNER

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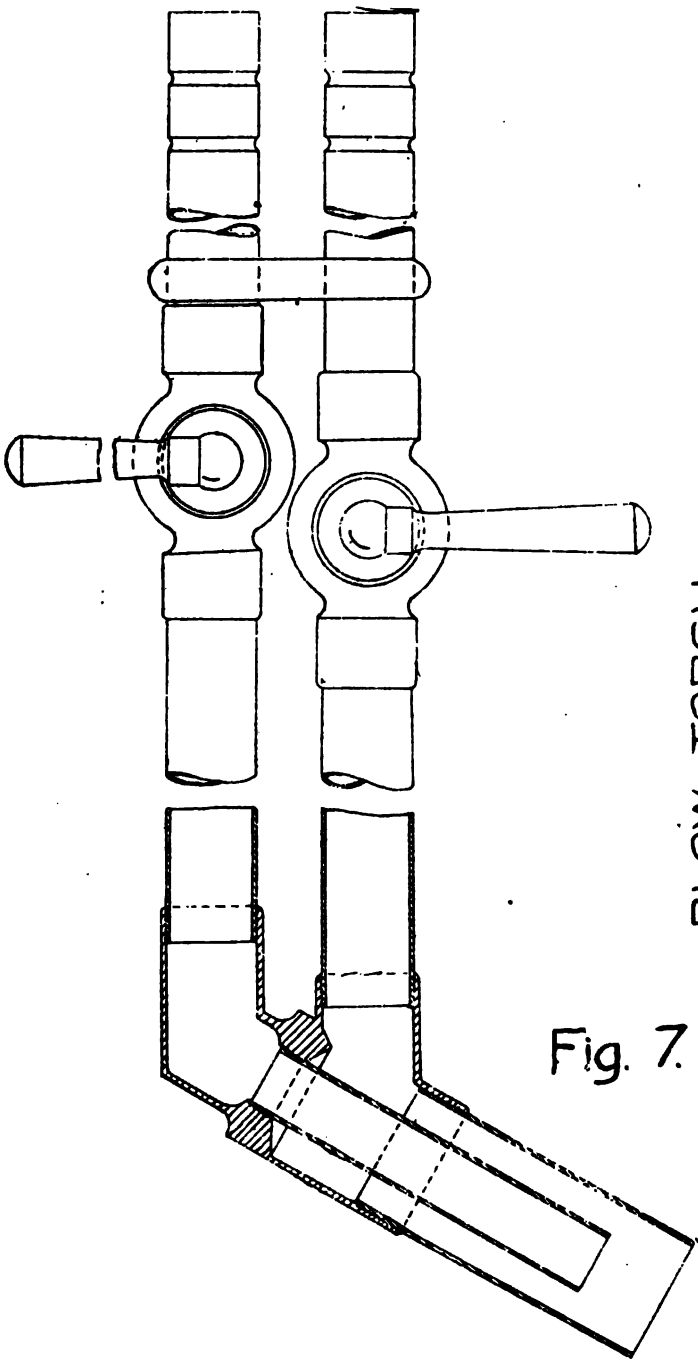

BLOW TORCH

Fig. 7.

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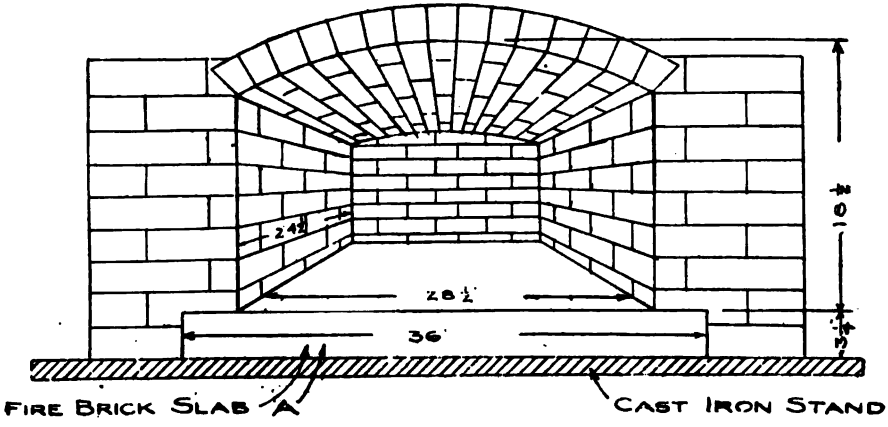

Fig. 8

FURNACE FOR BENDING GLASS

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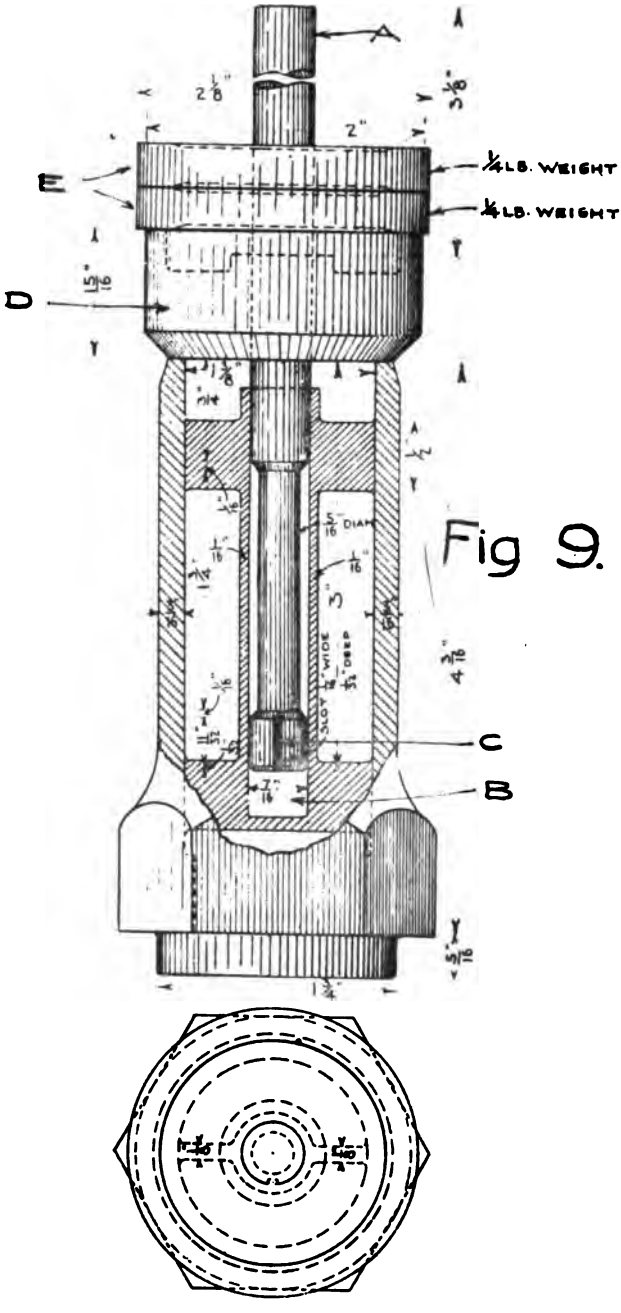

Fig 9.

AIR RELIEF VALVE

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Burners.

Figure 2 shows one of the eight burners used in the No. 1 Oven Furnace, illustrating the general method of putting blast burners in oven furnaces having a fire brick lining, into which the burners are inserted.

This recessing of the burners serves the double purpose of protecting it from the heat, and also of maintaining the flame, as it has been found that this type of burner cannot be kept lit, if in the open. One of the most interesting features of the use of gas with air pressure is the devices that are used under different conditions for the purpose of keeping the flame lit.

In the burner shown, attention is called to the small radiating orifices "A," which surround the main burner opening "B." Without these orifices, the main flame would blow out, and even with the orifices, the flame is maintained only when the end of the burner is surrounded by a projecting hood like the fire brick shown. Why the orifices and projecting hood act as they do is a matter of theory. Probably the small size of the tubes and the fact that the mixed air and gas issuing from them impinge on the hood, so reduce the speed at the point of combustion that there is less tendency to blow out. Then, too, the walls of the projecting hood, protect the tender flames from side draughts.

The gas and air mixture can be kept lighted, when it issues from one central opening at the burner nozzle, provided the flame plays against a fire brick or other surface, located close in front of the nozzle; but it is not as certain to stay lighted as the construction described above. Also, in some circular furnaces, burners of simple nozzles are used, by arranging two or more burners around the circumference, so set at a tangent, that the flames play around the circular wall in the same direction and thus tend to keep each other lighted.

Ferrofix Brazing Head:

Figure 3 shows the Ferrofix Brazing Head. The construction permits of keeping the burner lit in the open. The principles are the same as in the former burner shown on Figure 2. The secondary flame issues from the annular slit "A," instead

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of from small orifices, and the projecting hood is the wrought iron pipe "B" instead of fire brick.

When using the Ferrofix Head in constructing home-made brazing furnaces, we found that the head burned out very quickly. To overcome this, we protected it from the heat by cold-driving it in a cast iron collar. This collar is 3 inches long and ½ inch thick. The face of the wrought hood "B" is recessed 1 inch in the collar. When fitting a collar to a head, care must be taken not to close the circular space "A."

We have put the Ferrofix head to the following uses:

Home-made cylindrical brazing furnace equipped with five heads (the protectors being used) for brazing flanges on the large copper steam pipes of locomotives. We also used one head in a small furnace for the smaller copper pipes.

Two heads were placed under the vaporizing cap of a 125 H. P. Hornsby Akroyd Oil Engine. The cap must be heated to a dark red before the engine can be started. The two burners enable the consumer to start the engine in 15 minutes. We have 10 sets of these burners installed for this purpose. These burners replace the oil lamps originally furnished by the engine manufacturers.

Three heads were put in the fire box of an old charcoal brazing furnace. It is used for brazing the bottoms in copper pans of all sizes.

Two heads were adapted to braze the joints in ice cream cans.

Figure 4 shows the Ferrofix Head adapted to braze the copper cylinders of chemical engines. We used four heads here as some of the cylinders are made of ¼ inch copper, and a large volume of flame is needed.

We also put a ring of heads around a very large cauldron previously heated by steam. This cauldron is used for manufacturing axle grease.

The Machlet Burner Tip:

Figure 3 shows the Machlet burner tip. The construction permits of keeping the burner lit in the open. The principle

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of maintaining the flame of the burner is similar to that used with the Ferrofix Head.

The ribbons "A" are recessed ⅛ inch in the shell "B." This prevents the draught of air from blowing or sucking out the small flames which burn from the ports "C" and "D." The pressure of the gas and air is probably sufficiently cut (due to its impinging on the part "E"), to hold the flame to the burner. With this burner it appears that the small flames burning at "D" act as pilots to the flames burning at "C."

The tips are made of one size, ⅜ inch diameter, and can be set in rows in pipe burners of straight or circular form, or arranged in clusters, etc.

We have used the Machlet Tip in the following home-made appliances: In japanning ovens for enameling the frames of baby carriages and velocipedes and skylight frames. Under tinning furnaces and sawdust driers.

The Ribbon Burner:

Figure 5 shows the single ribbon burner. The feature of the ribbon burner is that it gives from end to end a continuous line of flame of uniform size, thus rendering it useful for such purposes as singeing fabrics, and roasting coffee, where a line of separate burners, with spaces between the flames would not answer.

The ribbon burner has been utilized as follows: Under the 6-foot cylinder of an old coal coffee roasting machine, the capacity of the cylinder being 350 pounds. Two ribbons were set in a pipe paralleling the cylinder, so that the two lines of flames impinged on the cylinder at an angle to each other. One of our customers was using a machine of German manufacture for singeing tapestry. The gas flame issued from a slot about four feet long, the slot being formed by two bevel-edged plates which could be adjusted and held by set-screws. The flame was uneven and at places intermittent. To overcome this trouble we took one of the ribbons out of a ribbon burner and set it in the slot, holding it by squeezing it between the beveled plates. The result was a steady, even flame which produced satisfactory results.

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Soft Metal Burner:

Still another burner is the Soft Metal Burner, shown on Figure 6. With this burner an intense heat can be maintained under cauldrons for melting metal, candy, etc. Figure 6 shows one of the sixteen stoves of our own design sold a consumer. It gives quicker results than any stove we know of, treating 40 pound batches of candy in fifteen minutes, instead of thirty for the stove replaced. The stove is equipped with the No. 6 Soft Metal Burner. The construction of the burner permits of its being lit in the open. The bottoms of the pans come within 8 inches of the top of the plug "C". A one-half inch sheet iron flare prevents the flame from touching the pan above the level of the syrup, thus preventing scorching.

The sight holes "G" are used to determine the condition of the flame when the pan is in place. When the stoves are not in use, the burners are protected from the dust peculiar to a candy shop, by sheet iron caps.

An old charcoal furnace, used for tinning objects and for annealing copper pans, was equipped with this burner.

This burner was also used under pots of old coal furnaces, for melting metal, under potash kettles, under kettles for supplying hot water, and in the frames of old coal candy furnaces.

Blow Torch:

The above brazing torch, shown in Figure 7, is a type of burner on the market which is useful for certain purposes. It will stay lit in the open, apparently because the gas and air mixture is burned at a point close to the injector. As already described, if the mixture is piped any distance from the injector, one of the several special types of burners, as described, must be used in order to maintain the flame.

This torch was used as shown in Figure 8 in a glass bending furnace. The flat pieces of glass are placed on the moulds which set in the furnace on the slab "A." The heat is then applied through the torch held in the hand of the operator until the glass forms to the mould. It is then removed and placed in an annealing oven to cool. The moulds vary in size,

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the largest one being 14 inches by 24 inches. To take care of the large moulds, the end of one of the torches had to be flattened out to a 2 inch oblong opening, thus enabling the operator to cover the mould with a solid sheet of flame. The flame must cover the mould, otherwise the glass will break.

RELIEF VALVE.

Figure 9 shows the construction of the air relief valve used on the Reichelm High Pressure Blower, and in some cases on the furnaces. This valve insures a constant pressure at the air injector of a furnace or furnaces, provided the capacity of the blower has not been exceeded. It also permits the air to escape when not needed at the furnace.

Where a blower is run in connection with a single furnace, which has an air drum with relief valve, the valve on the blower can be dispensed with or weighted down, and the surplus air allowed to escape at the furnace. When a number of furnaces is supplied by one blower, the escape valve on the furnace at the end of the line should be in use, and the valve on the other furnaces and blower may be weighted or fastened down. If the hissing noise made by an escape valve is annoying, the valve may be moved away by extending the connection.

Before starting a new set of appliances, the valve stem "A" is removed and oil is poured into the chamber "B." The oil acts as a cushion for the valve stem. The slot "C" in the valve stem permits the oil to flow into the upper part of the chamber "B," when the stem is inserted, and allows it to flow into the lower part when the air pressure raises the stem, thus acting as an automatic cushion, which insures a steady and non-fluctuating air pressure.

The stem and the attached part "D" represent a pressure of one-half pound. Each of the weights "E" equals one-quarter of a pound. Therefore, the valve shown is giving one pound air pressure. If for any reason a higher pressure is desired, extra weights may be put on the valve stem, being careful not to carry a pressure of over two pounds.

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INTRODUCTION OF APPLIANCES.

A sample line of most useful appliances should be carried in stock, and fitted up for practical demonstrations. By advertisement, by letters or by personal interviews, the appliances may be brought to the attention of manufacturers. The last method especially with one energetic salesman, seems to me the best. This salesman should have a knowledge of the work to be done. Very often this can be obtained by watching the operator do the work by the old method. From this observation he should be able to determine the temperature required to do the work, and the appliance or burner capable of generating that heat. It is not necessary for him to know how to treat the material, but only to give the heat. He must first find out the material the prospective consumer is using, what he is doing with it, and the color or heat at which he wants to work it. To the ordinary operator, temperatures are unknown quantities, and he judges his heats entirely by the eye, grading them in colors, such as dull red, cherry, bright cherry, lemon, orange, white, brilliant white, and dazzling white. These are the terms used by the metal workers. The man operating a china burning kiln speaks of rose, straw, and other colors more becoming to his artistic occupation, while the textile or hosiery worker has no use for a singeing burner which does not whistle when lighted.

After the salesman has received answer to his questions, he should know what appliance to recommend. For instance, if the consumer states that he wants to treat a straight carbon steel, the salesman knows (the size of the work permitting) that a No. 1 Oven Furnace is required. If the consumer states that he wants to treat high speed steel (the size of the work permitting), the salesman knows that a No. 38 Oven Furnace is the appliance to install. If the consumer has an appliance installed using coal, coke, charcoal, or oil, as fuel, and desires to change to gas, the salesman needs to know the proper burner, or burners, to recommend, or whether a complete gas furnace already on the market should be substituted. In this case and also where the consumer

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may have constructed a home-made appliance, and is in trouble with the burners, the salesman will probably have to consult the engineering or distribution department. In some cases it would be wise to start a consumer off with a small appliance, such as a bench torch, brazing torch, rivet heater, bench forge, or one of the many other small appliances, let him become acquainted with it, let him see what a number of uses these small appliances can be put to in his shop, or allow the salesman to size up the situation and determine whether or not it would pay to connect one of these small appliances on approval. Then have him work up the larger appliances. Of course, the salesman will run across some propositions where he will not be prepared to furnish the consumer with the proper information, then he must find out what the consumer wants, and have the office correspond with a manufacturer, stating the nature of the work to be done, and if thought necessary, parts may accompany the latter. This very often proves a mutual benefit. If the consumer wants to see his work treated before he accepts a proposition from the salesman, let the office arrange for a demonstration with the manufacturer of the appliance, and, if thought necessary, allow the salesman to accompany the prospective consumer.

CONNECTION OF APPLIANCES.

It is customary with us to give out the setting of the blower to some good machinist, or the consumer does the work. The blowers are sold under a guarantee, both as to efficiency and durability, and a careful inspection should be made after they have been installed. The blower should be well oiled, should not run over its maximum speed, and it is very essential that it is set level. If the belt used is a new one, see that it is taken up after a short period. A blower not well oiled will stick, and the wear on the bearings will be heavy. If a blower is not set level, the blades will bind on the head, causing them to stick, and there will be an uneven pull which will rapidly cause a leak through the bearings. This leak can be remedied by using babbitt metal, or a better method is to insert a brass collar. These collars are easily replaced, and the

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blower need not be taken apart when such repairing is required.

Before setting a blower, the shop conditions should be looked into. The shaft from which the power is to be taken may also be running heavy machinery such as drill presses, grind stones, polishing wheels, or an elevator may be operated. If there is a decided change of speed in the blower, due to the throwing in and out of the other machinery, point the defect out to the consumer, and tell him the appliance will give far better results if a constant speed is maintained on the blower. Blowers run by such shafts often cause the following complaints: "Your gas pressure is not steady; sometimes I have plenty of gas, and then the pressure drops." A slipping belt, sticky relief valve, oil in the air line, or water in the gas line are also causes of the above complaint, and when such a complaint is received, the inspector should take them all into consideration.

Of course, instead of using a blower, the air may be drawn from an existing high pressure system, by the use of reducing valves, provided the volume is ample.

Based on computer results, and allowing for a drop of about 50 tenths in the line, we have installed air pipes according to the following rule:

Size of Blower	Length of Connection* in Feet	Wrought Iron Pipe to be Used. Size.
1	0 to 50	2″
1	51 to 200	2½″
2	0 to 100	2½″
2	101 to 200	3″
3	0 to 100	3″
3	101 to 200	4″
4	0 to 50	3″
4	51 to 200	4″
5	0 to 50	4″
5	51 to 200	5″
6	0 to 100	5″
6	101 to 200	6″

*From outlet of blower to air injector where only one appliance is supplied or to first branch line where more than one appliance is supplied.

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In every case, the connection, as defined above, should be one size of pipe. For instance, a run of 60 feet from a No. 1 blower should be of 2½-inch pipe.

If the air line starting from the blower takes a perpendicular drop, put in a drip with a draw-off cock; you will find that oil from the blower will accumulate in the line.

Do not use tin air pipe, as it will cause trouble.

I would not recommend the installation of a melting furnace for melting brass—that is, not for continuous melting with artificial gas at a dollar a thousand. It can be melted for about half a cent per pound. This figure is taken from the total melt, and does not include the gates or bad castings. To get this figure, we changed the nozzle of the air injector and increased our air pressure from one pound to one and a quarter pounds. We thus received a quicker and higher heat, but at a sacrifice to the linings, which in the end did not pay. This was worked out with a No. 2 Down Draft Melting Furnace, which we changed to an up draft.

Do not connect a lead hardening furnace, soft metal furnace, or cyanide furnace with the lighting hole to the front, for if the pot should give away, as happens at times, the hot metal may injure the operator.

Do not connect an appliance under an automatic sprinkler.

Do not, as a rule, guarantee gas consumption, as the operator can, without knowing it, spoil your calculations by carrying the heat too high or too low. A turn of the gas valve will defeat your reckoning.

OPERATION OF APPLIANCES.

After an appliance has been sold and connected, the gas company's man should be the first one to start it off. Very often if the starting is left to the consumer, the appliance will receive a "black eye." Before starting a new appliance, the union between the injector "T" and the gas valve should be disconnected. There should be suction enough "produced by the air" to hold a light piece of paper to the opening.

In lighting air blast burners, if in the open, first turn on the gas and light it; then open the air cock gradually and adjust

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the gas and air cocks to give a flame of the size and type desired. If in a furnace of enclosure, a small quantity of air is turned on first to create a circulation in the furnace, and to expel any possible explosive mixture that may have accumulated. A piece of well lighted paper is then placed as near the burner or burners as possible. The gas is then turned on by a quick turn of the valve. As a rule, one can see the flame or the reflection denoting the ignition. A steady roaring indicates that the burners are lit. Adjust the gas and air valves so that a small blue flame will issue from the vents. With the furnaces having fire brick linings, proper burning conditions are not reached until the linings have become sufficiently heated to permit the normal supply of gas to be turned on.

In shutting off, first turn off gas, then the air immediately. The air should not play on the hot fire brick, as it would be liable to crack it. With furnaces having cast iron pots or retorts, oxidization would be occasioned by the air playing on same.

To bring a furnace up to the heat required, the maximum gas consumption is needed. After the desired heat has been reached, the air and gas valves should be adjusted until the heat wanted is maintained. This consumption is usually near to that given in the catalogue, but when piping up any of these appliances, the pipes should be made large enough to supply about double the quantity of gas given in the catalogue.

Whenever a reducing flame is required, as where steel parts are to be hardened, where cast iron pots or retorts are exposed to the flame, and in general whenever there must be no oxidation of the material in contact with the flame, excess gas must be carried. The presence of excess gas is always indicated by a small blue flame issuing from the vents of a furnace. When a furnace is opened, the excess gas prevents oxidation of the contents of the furnace by the atmosphere.

The cement used to lute and repair furnaces is known as Fire Clay Putty. This cement consists of fibre asbestos, cement and fire clay. When wanted for use, it is mixed with water to the consistency of putty. If the furnace is hot, it is

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well to mix the cement a little thinner to prevent it from becoming dry while using.

At times the bottom slabs of oven furnaces (which are fire brick) need renewing, caused by an explosion in the furnace, by allowing something heavy to drop on the slab, by allowing the air to play on the slab after the gas has been turned off, or general deterioration.

The entrance of the furnace is generally of smaller dimensions than the bottom heating space or slab. In such cases the slab is put in through a back entrance especially provided, this entrance being closed by luting in what is known as the back slab, and held in place by a plate pulled up with wing bolts.

When a new bottom slab is to be put in an old furnace, the back plates and slab are removed. Great care should be exercised in removing the back slab, for in many cases, it has cracked and is weak from constant heat. It is best removed by cutting out the fire clay putty from around the edges. This will loosen the slab, and it can then be forced out from the inside by tapping it evenly on all sides with a board. A back slab rarely stands removing more than twice. If the fire brick lining has been cracked, it should be luted with fire clay putty. A cold chisel may have to be used to remove deposits from the bottom, after the old slab is removed; then the bottom should be leveled with fire clay putty. The lining at the burner openings may become so deteriorated that it no longer protects the burners, and this should be carefully looked after and well luted, or, if badly burned away, a new lining should be put in.

The new slab is then put in, and care taken that the slab supports are in their proper positions, and that none of them obstruct the burner openings. The slab goes flush and level with the entrance sill and must rest on all of its supports, so that it will not rock. A play of ¼ inch should be allowed between the bottom slab and the back slab for expansion. When connecting an oven furnace, do not run the gas and air lines in such a way as to interfere with removing the back slab. The fire clay linings used are held in place by plaster-of-Paris, which not only holds the linings in position, but also prevents

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loss of heat. To reline a No. 1 Oven Furnace, first remove the burners, the front and back plates, then cut out the old lining. This leaves the outside case, which is fastened to the bottom plate. Cut eight channels in the new arched lining leading to the sides, two on each side of the vents at an angle of about 30 degrees from their centres. These channels will permit the plaster-of-Paris to flow freely over the sides. The channels may be cut with a diamond-pointed chisel, and the furrows smoothed down with a rough file. Place the lining in position, put on the back plate; then place the front arched slab, which is held in place by the front plate. Mix up a quantity of fire clay putty and lute all crevices, plug the burner openings, being sure that the fire clay putty extends through to the outside case; next plug the vent holes from the inside, then pour the plaster-of-Paris through the vents of the outside case. Be sure that the plaster-of-Paris is thoroughly mixed and very thin; if it is not, it will quickly set around the vents, and the job will have to be done over. Two men should be used to do the pouring, one for each vent. When the plaster-of-Paris starts to overflow, allow it to settle. You will find that about a bucketful will be required to finish the job. Allow the plaster-of-Paris to set for about a half day, then remove the fire clay plugs, insert the burners, and place the bottom slab and back slab in position, as previously stated.

To reline a cylindrical furnace, such as the No. 2 Down Draft Melter, place the lining on an even base, put the wrought iron case over the lining, mix up some fire clay putty, and stuff it down between the lining and the case, thus sealing the bottom, plug the burner openings, then pour the plaster-of-Paris to within about one inch from the top, face up with fire clay putty, and allow the plaster-of-Paris to set. Remove the plugs from the burner openings in the case and drill the openings for the burners in the lining (linings come undrilled). This drilling is no easy matter—that is, when not equipped with automatic drills. It is best to start the hole with a small chisel, being sure to get the right angle, for if you do not, the burners will not work properly. After a small hole has been worked through, ream it out to the desired size.

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To reline a No. 2 Gas Forge, remove the burners, front and back plates, put the new linings in position, mix up the fire clay putty and lute all crevices, plug the burner openings; then place the furnace face down on the floor, level it up with blocks, and pour the plaster-of-Paris between the lining and the case at the back, allowing it to set, which, with a small furnace, only takes a few minutes; then put the back plate and burners in place.

To reline the No. 5 Lead Hardening Furnace, remove the burners, top plate and cast iron case, place the bottom slab and oblong lining in position, lute all crevices with fire clay, and plug burner openings; then pour the plaster-of-Paris from the top. Allow it to set, and then put the top plate in place.

At times it may be necessary to take a blower apart. The Leiman blower is easily dismantled and reassembled, but with the American Blower, the reassembling is rather a difficult operation—that is, if one is not familiar with the blower. I have known two machinists to spend half a day assembling one of these blowers, the great difficulty being the replacing of the segments which travel in the eccentric grooves in the heads. After the head on the pulley side has been put into position, and the segments and blades entered on this side, the other head may be put into position as follows: Place the segments on the blades, push the head up until within about one-half inch from its permanent position, one man steadying the head with his left hand, while another man turns the pulley in the reverse direction. As the blades with the segments slipped on them come up parallel to the course of the groove, the man holding the head enters the first segment about one-quarter inch in the groove, and then, as the pulley is turned, the segments already in position will follow the course of the grooves, and the remaining segments will assume their proper positions to be entered.

LIST OF INSTALLATIONS.

The following is a list of the air blast furnaces installed to date in Philadelphia with the purpose for which they are used:

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Forges:

For treating high speed steel.
For heating steel parts to harden.
For forging.
For dressing tools.
For brazing.
For testing building material.
For bending iron.
For welding.

Rivet Heaters:

For heating rivets.
For bending small iron parts.
For brazing.
For heating steel parts to harden.
For small forging.

Oven Furnaces:

For heating steel parts to harden.
For annealing.
For case-hardening.
For bending special lenses of automobile lamps.
For pre-heating high speed steel.

The No. 38 Oven Furnace is used for treating high speed steel, as it is so constructed that a white heat may be carried.

Case-Hardening Furnaces:

For case-hardening.
For heating steel parts to harden.
For annealing.

No. 1, No. 2, No. 3 Soldering Iron Heaters:

For heating soldering irons.

Self-Heating Soldering Irons:

For general soldering.
For soldering leaded glass work.

Assay Furnaces:

For jewelry purposes.

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Melting Furnaces:

For melting babbitt and all other soft metals.
For lead hardening.
For cyanide hardening.
For blueing with saltpetre.
For melting valuable metals.

The No. 2 Down Draft Metal Furnace is used for testing fire brick. For treating steel for experimental work, and for brass melting.

Muffle Furnaces:

For enameling jewelry and other objects.
For annealing.

Lead Hardening Furnaces:

For lead hardening.
For melting soft metals.
For cyanide hardening.

Brazing Torches:

For soldering the bottoms in copper fire extinguishers.
For general soldering.
For hardening steel parts.
For tempering.
For bending glass.

Ferrofix Brazing Torches:

For brazing cast iron.
For brazing cup joints and flanges on copper tubing.

Brazing Tables:

For brazing parts to electric arc lamps.
For brazing tubing.
For repairing parts of machinery.

Oil Tempering Furnaces:

For oil tempering.
The No. 38 Oil Tempering Furnace is being used to tin copper fire extinguishers.
For blueing with saltpetre.

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Sweep Reducing Furnaces:

For reducing sweepings.
For melting soft metal.

No. 10 *Cluster Burner*:

For melting lead in small quantities.
Used under small home-made oil tempering pots.
Used under potash kettles.
For supplying hot water.
For drawing temper.
Used under home-made soft metal pots of small size.

American Three-Way Burner:

For heating small steel parts to harden.
For making incandescent electric light bulbs.

Cylindrical Furnaces:

For tinning.
For treating high-speed steel.
For heating long drills and reamers.
For annealing.
For case-hardening.

Adjustable Tire Heaters:

For putting on and removing wheel bands.

Speed Regulators:

Sold with automatic heating machines. These regulators enable the operator to pass the material through the machine at the right speed so as it will be heated properly. If the cylinder gets beyond the required heat, he speeds the machine; if the temperature drops, he decreases the speed. If the work is light, he speeds it up; if heavy, he cuts it down.

No. 15 *Automatic Heating Machine*:

For brazing umbrella rod tubing.

No. 17 *Automatic Heating Machine*:

For burning the oil off of hair pins, and hooks and eyes, and at the same time tempering them. The oil is burned off to allow the enamel to take to the steel.

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No. 29 Automatic Heating Machine:

We have nine of these machines hardening steel balls, the balls varying from $^{3}/_{16}$ inch to 1 inch in diameter.

The machine consists of an outer case, or body, lined with firebrick, in which the burners were inserted. The flames play on a revolving cast iron retort, in which there is a spiral. The feeding chamber is attached to one end of the retort. The balls are fed into the retort by a scoop, which is attached to the inside of the feeding chamber. The spiral works them through to the outlet of the retort, where they are deposited into a bath.

We had considerable trouble with the first machine installed, due to the burning out of the cast-iron retort. The first retort burned out in about two weeks. This burning out was undoubtedly caused by the operator, who did not follow instructions, i. e., to carry excess gas and a heat of not over 1700 degrees to 1800 degrees Fahrenheit.

Under proper treatment, the retort lasts six to seven weeks.

We also experienced trouble due to the expansion of the cast-iron retort. The collar of the feeding chamber is attached to the retort by machine screws. The rollers which support this end of the retort run on the collar. When the retort expanded to a certain point, the rollers slipped off of the collar on to the retort, thus allowing the retort to drop about quarter of an inch.

I am of the opinion that this has a great deal to do with the breaking of the retort. This dropping of the retort was overcome by putting a device on the machine which permitted the rollers to be adjusted.

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AIR BLAST GAS APPLIANCES.

By W. H. Allen, Newark, N. J.

The object and purpose of this paper is to treat solely of the blast or industrial gas appliance; its value to the gas company, and the large increased consumption derived by its introduction and use.

Not until within the last few years have gas companies shown much interest in development along these lines, because they have not fully realized the value and importance of the industrial possibilities of their business. I feel warranted in making this assertion from facts, and base my proof upon personal experience and observation. The numerous inquiries constantly being made by gas men prove conclusively that these appliances are not as universally known and understood as they should be.

Every gas man is familiar with the gas range and what it has accomplished and is still accomplishing from the domestic point of view. They have satisfied themselves of its merit and know what a valuable adjunct it has proven by the greatly increased sales of gas derived from it.

Having demonstrated the worth of the range for domestic purposes we should now turn our efforts to larger avenues for increases by putting the same amount of energy and enthusiasm in the sale of these industrial appliances for manufacturers as has hitherto been displayed in the sale of household appliances. They recommend themselves as a source of greater revenue because they show far greater consumption than the ordinary domestic appliance. This is due to the increased length of time they are in use, for in the application of the law of averages, they stand out as an all-day load.

If you will stop to consider that a single one of these industrial appliances is worth far more, has a much greater consumption with approximately the same cost per installation and

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brings less trouble and complaint during the course of the year than a gas range, the sale of such a business-bringer cannot fail to appeal as worthy of more consideration and investigation than has heretofore been accorded it.

As an example of the value and benefit a gas company may derive from the sale and use of these appliances, permit me to mention the consumption of ten actual consumers during 1906 which was 73,771,700 cubic feet. For a period of three years the same number aggregated a total of 261,697,000 cubic feet. Further, a recent sale just completed to one consumer calls for a demand of 10,000 cubic feet per hour on a $^1/_3$ capacity at present. When in full operation the total consumption may easily be figured.

In addition to the above, many hundred more could be mentioned who are using gas under like conditions, but to quote the consumption of all in use in a certain territory would, I am afraid, appeal to many of you as preposterous, and might be considered questionable.

Again, as to the increase in the sales of these appliances, it is interesting to note that in one district for 1905 there were sold 228; in 1906, 466, and for the first six months of 1907, 160.

I mention these facts to show you the gains which are being made solely by energy and effort in pushing this end of the business. To do this it is necessary to appreciate the value and importance of availing ourselves of every opportunity to educate the unlearned, to convince the skeptical and to prove to the doubtful manufacturer, that, by the use of gas appliances, economy and greater results are obtained than by the use of other fuels.

The line of appliances which we have adopted and recommend to our customers we have thoroughly tested and found to be of good construction, efficiency, durability and perfect in every respect. Further, the guarantee, liberality and fairness of the manufacturers of appliances which is afforded by a 60 days' trial insures us against loss in demonstrating them.

There are a number of manufacturers of industrial appliances, but after experience we decided to confine ourselves exclusively to one line in order that our men become familiar

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with it and be able to make adjustments and repairs with facility.

The various manufacturing applications for which heat—by the use of gas or any other fuel—is required are melting, boiling or fusing and the many and numerous uses to which gas devices can be applied to these, either for manufacturing, laboratory, metallurgical or chemical purposes are inexhaustible. The appliances most universally called for and which are in most general use are the following:

Case Hardening Furnace,
Annealing "
Oven
Tempering "
Melting "
Forges
Blow-pipes
Heating Machines.

When special burners or devices of any kind are required (not made, or carried in stock) we take it up direct with the manufacturer and they are especially designed and made for us. When this is done they are guaranteed the same as any regular appliance.

A few special adaptations where the use of gas has proven successful, displacing other fuels may prove of interest.

One of these is a device for mirror drying. This was made in the form of a large oven; the dimensions being about 16 x 8 x 4, two longitudinal burners were installed at the bottom and the plates of glass of various shapes were placed on top and resembled in appearance an enormous cake griddle. The coal process was formerly used, but with this gas device a great saving of time is accomplished and no expense is incurred to keep up heats—a requirement necessary when other fuels are used. With this new device the heat is obtained a few minutes after lighting and is ready at all times.

A heating machine for hardening, annealing and other processes of which we have a number in use, is also interesting. In one jewelry manufacturing establishment where it is installed 25,000 small steel tubes are annealed daily. This ma-

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chine does the work perfectly and has proven a great saving to the manufacturer in two ways: First, because of the accuracy of temperature, there being apparently no loss of stock from overheating; and Second, because formerly it was necessary to have this operation done outside the factory, which occasioned a loss of time.

A machine of this type is in use at the pencil factory of Joseph Dixon Co., Jersey City, where the small metal caps used on pencils are annealed, and enough of these caps are prepared in one day to supply the pencil output for a month or more. Its one great feature is the absolute uniformity of the desired heats.

This particular appliance requires no skilled labor and an increased amount of work can be produced by it. It feeds itself automatically from a hopper, which a boy can operate.

Another device is a burner used for drying out barrels, hogsheads and vats, especially adapted to breweries.

Numerous storage casks and vats used in breweries have to be dried out occasionally to prevent them from becoming too thoroughly saturated with liquor, and to keep them from souring, which affects and destroys their contents, and entails considerable loss when not properly cared for.

Formerly, and in many places they still use a small charcoal furnace, which requires at least two days for the drying. The gases incident thereto are very objectionable to the workmen, and at times have resulted in asphyxiation. With the use of a small gas burner large casks may be dried in eight hours and smaller ones in three or four. Brewers will appreciate the convenience, as well as the time saved by the use of this appliance if properly presented to them.

As there are many of these institutions among our Western friends, especially in the vicinity of Milwaukee and St. Louis, these appliances deserve their consideration.

Among the desirable features of all air blast and industrial appliances are better work, more work per unit of time, less labor, cleaner conditions, less fire risk, less room, less skilled labor and a greater uniformity in work produced.

In addition to these there is the absolute regulation of tem-

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perature by which the most exact and critical heat requirements may be obtained, whereas with other fuels this is almost impossible. Then there is not only ease but rapidity with which any desired degree of heat within the range of gas can be obtained.

As you all know, these features are very essential and important in all lines of manufacture, and quite indispensable in the treatment of metals and many manufactured products. Under their possibilities of perfect control the mechanic, by his practised eye, can readily judge the condition of his work without undergoing the labor and trouble necessary where other fuels are used.

To further enumerate would occupy your time unnecessarily, for I am well aware of your familiarity with many of these devices.

As a suggestion I would say that the catalogues issued by the various manufacturers not only illustrate their many appliances but are also descriptive. A well-defined outline is usually given of every appliance, telling what it will do and the purpose for which it is made. This enables one to decide without much trouble the kind and size of appliance he needs by the nature of the work he wishes to perform.

The various uses to which these air blast appliances may be put need not be enumerated, as they include all processes known to the manufacturing world. Without fear of contradiction, I think we have installed nearly every made type, in one style or another, and to describe their working would be futile. They are in operation and give entire satisfaction, and to have one returned is an exception. Their value and worth are fully appreciated and cheerfully recommended by all manufacturers in our territory using them.

In interesting manufacturers, as a rule, you will meet with objections on the part of workmen, who, as many term it, are "up against it." Especially is this true where a superintendent has inaugurated or installed an idea of his own, and does not wish to have another supersede or prove a superior method. You will meet obstacles and find it hard to make progress at first, but by tact, liberal terms and free trials, success will follow in most instances.

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Many times it has taken months to perfect a sale, but we eventually win by conclusively proving superiority and economy. The latter is the most convincing argument to manufacturers, and is the chief aim for which all are striving. Owing to the keen competition of to-day this is especially true in the production of manufactured articles.

In order to obtain good results and accomplish the purpose of interesting manufacturers in these lines, constant and regular visits should be made. Spasmodic visitations are not appreciated and do not result in any real good. After sales are made it is well to learn from your consumer whether the results obtained are satisfactory and meet expectations. Show him that you take an interest in his welfare as it may result in further sales. Also see that promises as to efficient service are fulfilled, thus keeping good faith.

With reference to the various kinds of air-blast appliances made and offered for sale, I think extreme care and judgment should be used in their selection and adoption, for if they are found to be of poor construction, inefficient and expensive in operation, they will prove disastrous to you, and all your efforts in that direction will be fruitless. Therefore let me advise you to be careful in taking up and approving any that have not been tried until you have practically demonstrated its worth and capability of performing the work for which it is designed.

In conclusion, I think the subject is one which should and must interest and appeal to all gas men. It think it behooves us to push this branch of our business vigorously and to the utmost, using every opportunity to increase a demand for our commodity. The large and almost unentered field afforded by the use of gas for mechanical purposes should engage the serious attention and enlist the activities of everyone identified with this industry. Both the manufacturing and the commercial end of a gas company should take a keen interest in the steady advancement and promotion of the industrial uses of gas. Its possibilities are only in their infancy, and we can scarcely form any clear conception of the ultimate growth in gas consumption to be derived from an intelligent and energetic prosecution of its sale along the lines indicated by this paper.

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THE PRESIDENT: The third paper on this subject is by Mr. S. Tully Wilson, and is presented by request. Is Mr. Wilson present?

MR. DOHERTY: He is not present, Mr. President.

THE PRESIDENT: Is there anybody authorized to read the paper for Mr. Wilson? In that case it will not be read.

AIR BLAST GAS APPLIANCES.

BY S. TULLY WILSON, DENVER, COLO.

(Presented but not read at Meeting.)

In visiting a number of large cities recently, the writer has been surprised at the comparatively small amount of attention which is paid to the industrial gas appliances.

We know that they are almost invariably splendid revenue producers, not only because they consume considerable gas and run long hours, as a rule, but because the consumption comes usually at the time when it is most desired,—that is in the valley of the load curve. Unlike domestic fuel appliances, they produce about the same revenue for each of the twelve months, require little attention and are usually paid for in full soon after their installation; and yet there are few managers who will permit an expenditure to obtain this class of business pro ratio to the consumption, compared to domestic appliances.

Every new domestic fuel or illuminating consumer you take on, just adds so much to the necessary size of your manufacturing and distributing equipment, while most industrial consumption comes during the hours when the equipment is least taxed and assists toward the straight line load curve for which you are all striving. It is noticeable that those companies having the best reputation for business acumen and good results are almost invariably pushing industrial fuel appliances.

A rivet heater, a muffle furnace or a tempering and annealing furnace, consuming gas at the rate of 200 feet an hour and running 6 to 10 hours a day, are certainly very desirable appliances to install. Compare the revenue from this class of

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business to the revenue obtained from domestic appliances. Considering this matter of revenue, the time when the consumption takes place must not be overlooked, for if we consider this point, we can well afford to sell gas for such purposes at a lower rate and still obtain the same or greater profit which we would from the domestic consumption.

The first essential in an industrial appliance campaign is to obtain the services of a man who is familiar with the appliances available on the market, who is capable of adapting appliances and burners to uses for which they were not specifically intended and of good commercial training.

This means practically a commercial engineer, and there are not perhaps many available; but an engineer and one or more commercial men can produce wonderful results.

It is necessary with nearly all air blast gas appliances and many industrial appliances working without blast, to have them installed by an expert and have them demonstrated before the purchaser can undertake to operate them himself, for it is possible for him to have an explosion which may make him afraid to continue its use, or what is more likely, he will get a poor adjustment which will not produce the desired results, when he will condemn the appliance.

If the first gas appliance installed is successful, it is usually an easy matter to install others which you can recommend, and with subsequent installations, your consumer will be much more patient; but the greatest of care should be given the first installation as your future prospects depend much upon it.

This applies also to the first installation of any new class of appliance, for usually the first question asked will be, "Who uses one?" and the subsequent sales are always facilitated if a similar appliance is being successfully operated by a competitor.

It is frequently a problem for the salesmen to know when to recommend air blast; he knows frequently that he could make a sale of the appliance if it were not for the cost of a positive blower and frequently a motor also; and often he will install an appliance without a blast against his better judgment because of the difference in first cost.

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This problem seems to be one entirely of temperature. We do not believe it necessary nor desirable to have blast for a domestic gas range, yet to melt gold or iron we know that it is; there must be a line between these two points.

The Fletcher concentric ring burner will probably produce as high a temperature, if properly applied to a furnace, as any other. It is widely known and used, and yet an ordinary bunsen burner of the same capacity or consumption, equaled it in laboratory experiments and in practice at a considerably less first cost.

With a gas of moderate calorific value, crucible assays of precious metals can be made without a blast; it is slow and not commercial, but this gives an idea of the limit of possibilities.

Soldering iron furnaces are frequently used with a blast, and yet it is not even desired to get the temperature of the iron above ten or twelve hundred degrees Fahrenheit at most; it would seem, therefore, that if the furnace were properly constructed, a blast would not be necessary.

We have used with marked success a soldering furnace, which has two chambers that will each just hold nicely a large soldering copper and each is heated independently.

The burner is placed below and to the side of the copper—the flame issuing horizontally, circling the iron and passing out a flue above the burner. The furnace is well lined with insulating refractory material and gets very hot with only ordinary gas. They make use of the reverberatory principle in this furnace with marked success.

In tempering tools, it is customary to use a blast, while the temperature required for this work can easily be obtained without, as has been demonstrated.

They make a tempering and annealing furnace in which temperatures approaching eighteen hundred to two thousand degrees have been obtained without a blast, and this has been demonstrated to be ample for this class of work. Parts of rock drills which require a very uniform temper are being very successfully handled in several of these furnaces.

Another good illustration is the firing of china, which is done perfectly without a blast.

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These examples are given as illustrations of the limit of temperature obtainable in practice with atmospheric burners.

When a temperature of two thousand degrees Fahrenheit, or over, is required with ordinary coal gas, a blast must be used, but here again there is plenty of room for variation. If the temperatures illustrated can be obtained without a blast, will not a slight blast augment these temperatures? It naturally should, and this theory has been verified in the production of a muffle furnace, which, as has been frequently proven, gives ample heat for crucible and scorification assays and cupelling in a commercial way, with a blast furnished by a thirty-three watt motor directly connected to a blower, attached to the frame of the furnace and the whole apparatus at a moderate expense.

The next step in air blast comes with the positive blower, operating usually to produce a pressure of one and one-half to two and one-half pounds. With this much air pressure, it is an easy matter to melt silver, gold or wrought iron, as we have obtained over three thousand two hundred degrees with one and one-half pounds of air, and gas of low calorific value.

The American Gas Furnace Company have long been leaders in the production of this class of goods, the United States mints using their muffle and crucible furnaces with splendid results.

The Chicago Flexible Shaft Company of Chicago have also done good work in this line and have produced a number of furnaces of very pleasing and practical design, and successful operation. The Improved Appliance Company have made a rivet heater working with blast which has proven quite a success. Three thousand degrees are easily obtained with this appliance. If the flame is properly adjusted, there is no trouble with scale whatever, and, as may be seen by the temperature mentioned, the rivets may be easily melted, and forging or welding may readily be done in this furnace. But a list of all the appliances available for the commercial engineer would be so long as to be impracticable.

This paper is intentionally superficial, it being the writer's opinion that there are but few men in this Institute who would

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bear with the details. Only a few appliances and manufacturers have been mentioned, but to those who wish the names of the manufacturers of gas-burning appliances of any description, I will say that I have much of this data available, and will take pleasure in answering correspondence on this subject.

Discussion.

The President: We will proceed to the discussion of the papers read.

Mr. H. W. Terry: In regard to air blast furnaces there is one point which I wish to bring to the attention of this meeting, and that is the actual consumption versus the builders' rated consumption. In our district, we recently made some tests of some air blast appliances. The consumer operated the furnace while a representative of the gas company took the readings of the test. The results showed that the actual consumption was 100 per cent. more than the builders' rating. In an investigation of this, by the maker of the gas appliance and the gas company, we found the difference was in the way the furnace was operated. A slight change of adjustment brought the consumer's rating to that of the builders' without changing the heating value. I think that a periodic inspection on the part of the gas companies would result in better feeling on the part of the consumer towards the company, and also lead to the installing of more appliances.

The President: Mr. Barnes, I am told that we may hope to hear from you on this subject.

Mr. H. L. Barnes: Mr. President and Gentlemen: If you would kindly tell me what you would have me say, I shall be very glad indeed to say it. That probably is an evasive means of approaching the subject, but I know of no hard and fast rules that could be laid down for procedure along the industrial line. I, by all means, heartily agree with Mr. Allen, that the gas companies in general have neglected or overlooked this means of disposing of their product.

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I think I am justified in saying that the root of the evil lies in the fact that the gas company has not had available a man or men suitably schooled for the work. Ordinarily, when a proposition is laid before you for your consideration the first step taken by yourself will be to mentally note the calibre of the party presenting the proposition. For instance, take our friend, the engineer. If someone walked into your works and stated that he had the details of some new method of producing water gas, you would at once sit up and take notice, sizing up your visitor in a twinkling; if your impression of him were favorable you would probably lay down your pen and listen for a while. If, on the other hand, your mental note of the man did not impress you, you would probably be extremely busy at the moment and beg to be excused. Now, what is true of yourself, is equally true as regards the busy manufacturer.

Following this line of argument, some of the trouble may be easily traced; the average manufacturer having many propositions confronting him, an outcome of competition, has not the time to devote to a man who but vaguely understands the proposition he is endeavoring to present. Then, again, human nature plays a strong part and in favor of the gas company when the industrial branch of the industry is being considered. If you can get something for nothing you generally make some effort, however slight, to secure that something. Now here is the point: if the manufacturer realizes that the representative of the gas company calling upon him has some knowledge, some process or some suggestion of merit, the principles of which will be given gratis, there is no question but what our gas company man will receive a courteous welcome.

I feel obliged, gentlemen, to repeat my opening remark, that if you will give me the cue as to what to say I will say it, for it is extremely hard to bring out points which can be applied broadcast, there are so many propositions in the industrial field, the principles of which are identical, yet the application is manifold. Two concerns may be producing almost identically the same goods, both as to style and grade, yet their mechanics down in the furnace room or in the machine shop, having been schooled along different lines, handle the details

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of the product differently; therefore, it is absolutely imperative that a man to make a success of the industrial department of a gas company must understand not only the principles involved by the application of heat to iron and steel, but also the various ways of application and the different results which will be obtained. The foundation for this knowledge may be readily gained, as some of the gas furnace manufacturers are glad to admit a man to their factory who comes with the indorsement of a gas company as the industrial man.

I would suggest, gentlemen, that a few inquiries be made at your local manufacturing plants wherever a heating operation of any kind is likely to be in use; if the plant is using coal you can save them money and produce an absolutely uniform product by introducing gas as a fuel.

The one all-important point in connection with this industrial department is the selection of the man to push the line. He must have a natural tendency for mechanics, for he will be called upon to figure, not only the furnace proposition but blower requirements, horse power to maintain the blower, shafting, pulleys and belt stress.

Now, gentlemen, I do not know that I can say any more, other than for those of you who are interested I will leave with the Secretary a number of photographs taken in Hartford of equipment installed within the last year and a half. You will find no printing matter in connection with the photos, but I shall be glad to answer any questions regarding them. I thank you.

THE PRESIDENT: Any further discussion of the papers?

MR. DONALD MCDONALD (Louisville): Mr. President, Mr. Eavenson and Mr. Allen have both shown so much knowledge of this class of apparatus, that I want to ask them both if they have ever tried to pre-heat the blast air as a means of getting higher flame temperature. I have done that, and have gotten a very much higher temperature. While we have tried it, we have not tried it in such a way that I feel that I know very much about, and I would like to know if either of those gentlemen have had any experience along that line.

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MR. W. H. ALLEN: I do not think I have ever tried that. I have heard of it, and I appreciate that that might be done, but I have had no experience.

MR. DONALD MCDONALD: With natural gas without an air blast you are not likely to get anything like the temperature necessary for brazing, but by pre-heating the blast air we got quite an increase of temperature. It seems to me that that points to a way of getting very much higher temperatures where such temperatures are needed. It may be that you have come across a blast furnace which you would use in doing that. I would like to hear the matter discussed.

MR. W. K. EAVENSON: We have tried heating the air just before it was mixed with the gas. We also tried heating the mixture just before it reached the burner, but without noticeable results over the old method.

MR. DONALD MCDONALD: I would be afraid of that for two reasons: one is that you might drop lampblack, and the other is that you will get explosions if you mix hot air and gas before the point at which you want the flame. You do not take either of those risks when you do not heat the gas, and the air being eight or ten times as heavy as the gas, there is very little loss in heating the air and not heating the gas.

MR. FREDERICK W. STONE: I do not see why Mr. McDonald finds it necessary to heat the air.

MR. MCDONALD: So as to get a higher flame temperature.

MR. STONE: I think it can be done and save all that work of pre-heating the air.

MR. MCDONALD: How do you mean? By forced draft?

MR. STONE: Do you use natural pressure or forced draft? I think you can get the same temperature that you are after by depending on the natural pressure.

MR. MCDONALD: Which do you use?

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MR. STONE: We use the forced draft. We use the blast furnace.

MR. H. L. DOHERTY: Mr. President, I believe if Mr. McDonald will make some careful tests he will find that he gains nothing in flame temperature by putting in the air in that way. Practically, there does not seem to be any gain in flame temperature by pre-heating the air, although theoretically, perhaps, it would seem as though that should be done. I think that practical results have shown that pre-heating the mixture or either element, or both elements does not increase your possible flame temperature, and that you will not get a very high temperature by heating the air. On a series of tests that we carried out, we were unable to get any increase in temperature by heating the elements. We could not explain the reason why, but in some industrial work where that was tried on our producers, and where we wanted to get a higher temperature, that was the result. My own theory of it is that the nitrogen which we ordinarily consider as inert, when it is introduced, exerts an influence, and excess heat goes to form some nitrous oxide, and these oxides do not break up again until the temperature goes below that point. We got practically the same temperature on our experiment by preheating the air as we did without preheating. It may not be the same under all conditions, but as we tried the experiment that was the result. By preheating, we had an increase of economy, but we did not increase the flame temperature.

MR. DONALD MCDONALD: Mr. President, I have found out what I wanted to know, provided it is true. I have always understood that flame temperature was that point to which the combustion of a fuel was capable of heating the products of that combustion, and therefore, if you heat one of the elements of this product of combustion first and do not get beyond the point at which the two elements will combine, I cannot understand Mr. Doherty's contention that you would not get a higher flame temperature. I wanted to get the view of some of the other members, and I am much obliged for the expression of opinion which has been brought out. The experiments

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which we tried could not be dignified by calling them scientific, and I wanted to know what the experience of some of the others had been.

MR. H. L. DOHERTY: By preheating the elements you add wonderfully to your economy in some classes of work, and it may add to the flame temperature, but I believe from the experiments that I have made that it does not do it. I think it would be interesting if we could have the opinion of others, or the testimony of those here who have carried on experiments of that sort with regard to this matter. I am inclined to think that Mr. McKay has tried some experiments on this subject. I know that theoretically you ought to raise your flame temperature just as much as you preheat, but that is not what you get in practice.

MR. HENRY I. LEA: Mr. President, in the application of producer gas made for the operation of engines, we have tried that, and we think we can get quite an increase of temperature by preheating the air. For instance in gas made from anthracite coal we have been able to maintain a temperature of about two thousand degrees or a little higher without preheating, but by running the waste gases through a series of flues, heating the incoming air and gas, we have been able to carry it up to 2850 degrees F. I suspect that the results which Mr. Doherty has arrived at in his experiments were due to burning the gas in some sort of furnace in which the radiation or other incidental losses have borne an undue proportion or a variable proportion. I do not know what conditions these experiments were tried under, but I am very certain that under the conditions we had, we did get a higher temperature by taking advantage of recuperation. We tried it time after time, checking our results with LeChatelier pyrometers in duplicate, both duly tested.

THE PRESIDENT: Any further discussion of this paper? If not, we will proceed to the next one. The next paper in order would be Mr. W. A. Baehr's "Bulletin of Instructions on the Care and Operation of Recuperative Benches." I under-

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stand that Mr. Baehr is not here. What, if any, action will you take?

MR. E. G. COWDERY: Mr. President, I understand that Mr. Baehr was obliged to go to St. Louis yesterday on account of some arrangements which it was necessary for him to make in connection with the balloon ascensions which are to take place there soon. I would therefore move you that the paper by Mr. Baehr be not taken up, but that like all papers which may need revision by the Publication Committee, it be referred to that committee, and that it appear in the Proceedings, and that any discussion on the paper may be put in writing and sent to the Secretary for insertion in the Proceedings in a like manner.

Motion seconded.

THE PRESIDENT: Gentlemen, you have heard the motion. Are there any remarks?

MR. A. E. FORSTALL: Should there not be some limit of time within which discussion on Mr. Baehr's paper will be accepted?

THE PRESIDENT: Yes, but I think that would be a difficult thing to settle. The discussion, of course, will have to be in before the publication of the Proceedings.

A MEMBER: How would it do to make it thirty days?

MR. A. E. FORSTALL: I would suggest that if such discussion is not in within three weeks that it be understood that it is not to be included.

THE PRESIDENT: Do you make that as an amendment to Mr. Cowdery's motion?

MR. A. E. FORSTALL: If Mr. Cowdery has no objection that can be included.

THE PRESIDENT: Is that included, Mr. Cowdery?

MR. E. G. COWDERY: Yes, that is agreeable to me.

THE PRESIDENT: Then, gentlemen, you have heard the motion. Those in favor please say "Aye." Contrary minds "No." Carried.

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A BULLETIN
OF INSTRUCTIONS ON THE CARE AND OPERATION OF RECUPERATIVE BENCHES.

By W. A. Barhr, St. Louis, Mo.

When I was requested to write this paper by Mr. Walton Clark, he expressed a desire that I should deduce a set of rules for the care and operation of recuperative benches which should be so concise and simple that any retort house foreman should be able to readily understand and follow them. I will endeavor to do this, and will formulate such instructions at the end of this paper. Prior to doing so, however, it appears desirable that some of the elementary principles of recuperative bench construction and operation, as well as of thermochemical actions and reactions should be presented, and an effort made to harmonize a number of existing conditions in regard to a rational method of rating benches, also as to definitions of styles of construction and names of parts. It also appears highly desirable to endeavor to exhibit a table of data regarding actual results obtained in practice in the more or less representative gas plants of this country, in order that a person might readily refer thereto, and thereby compare the outcome of his efforts for improvement with those actually accomplished elsewhere.

No attempt will be made in this paper to compare horizontal, inclined and vertical retort construction, nor will I endeavor to cover the operation of the two latter types. Appended is a list of references which were consulted during the preparation of this paper.

RECUPERATIVE, OR REGENERATIVE.—REVERBERATORY.

A great deal of confusion exists as to whether gas benches as ordinarily built are of recuperative or of regenerative construction. We should inquire into this matter, and see if the

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question cannot be determined. The Century Dictionary and Cyclopedia supplies us with the following definitions :—

" Recuperate. v.—To recover ; regain.

Recuperator. n.—1. One who or that which recuperates, or recovers.

2. That part of the Ponsard furnace which answers the same purpose as the regenerator of the Siemens regeneration furnace. See regenerator.

Regenerate. v.—1. To generate or produce anew ; reproduce.

Regenerative. a.—1. Producing regeneration; renewing.

2. In metallurgy, on the principle of the Siemens regenerator, or so constructed as to utilize that method of economizing fuel, as in the term regenerative gas furnace. See regenerator.

Regenerative Burner.—In gas lighting, a device by which the current of gas is heated before it reaches the flame, thus making combustion more complete.

Regenerative Furnace.—A furnace in which the waste heat of the products of combustion is utilized by being transferred to either the air or the combustible gases, or both, entering the furnace. This transfer is effected by means of so-called ' regenerators.'

Regenerator. n.—2. In metallurgy, a chamber filled with a checker work of fire-bricks; that part of a regenerative furnace in which the waste heat of the gases escaping from the hearth is, by reversal of the draft at suitable intervals, alternately stored up and given out to the gas and air entering the furnace. The idea of employing what is now generally called the ' regenerative system ' of heating was first conceived by Robert Stirling, in 1816, but his arrangement for carrying it out was not a practical one. The present form of the furnace, and in general the successful application of the principle, constituting a highly important improvement in the consumption of fuel, are due to the brothers Siemens. The regenerative system has already been extensively applied to various metallurgical and manufacturing processes, and is likely to receive still further development. Ac-

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cording to the Siemens regenerative method, there must be at least one pair of regenerative chambers, in order that the heat may be in process of being stored up in one while being utilized in the other. In the Siemens regenerative reheating- or mill-furnace, there are two pairs of chambers, each pair consisting of one larger and one smaller chamber, through one of which the air passes, and through the other the gas on its way to the furnace. The so-called 'Ponsard recuperator' is a form of regenerator in which, by an ingenious arrangement of solid and hollow fire-bricks, the current is made continuous in one direction, instead of requiring reversal as in the Siemens regenerative furnace. This form of furnace has been employed for reheating in rolling mills.

Reverberate. v.—1. To beat back; repel; repulse.

3. To turn back; drive back; bend back; reflect; as reverberate rays of light or heat.

4. Specifically, to deflect (flame or heat) as in a reverberatory furnace.

Reverberatory furnace.—A furnace in which the fuel is not brought directly in contact with the material to be acted on by the fire, but which is so arranged that the flame of the burning gases plays over or is 'reverberated' upon the ore or metal under treatment."

The Standard Dictionary, Nelson's Encyclopedia, and Knight's American Mechanical Dictionary give definitions of "regenerator," and "regenerating furnace," which are not as complete as those of the Century Dictionary, but which bring out the idea of reversal of flow.

The following extract from the Encyclopedia Britannica serves to confirm the essential principles of a reverberatory furnace:

"Reverberatory Furnace.—Blast furnaces are, from the intimate contact between the burden to be smelted and the fuel, the least wasteful of heat; but their use supposes the possibility of obtaining fuel of good quality and free from sulphur or other substances likely to deteriorate the metal produced. In all cases, therefore, where it is desired to do the work out of contact with the

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solid fuel, the operation of burning or heat-producing must be performed in a special fire-place or combustion chamber, the body of flame and heated gas being afterwards made to act upon the surface of the material exposed in a broad thin layer in the working bed or laboratory of the furnace by reverberation from the low vaulted roof covering the bed. Such furnaces are known by the general name of reverberatory or reverbatory furnaces, also as air or wind furnaces, to distinguish them from those worked with compressed air or blast."

I believe these definitions of a reverberatory furnace as covered in the Century Dictionary and Encyclopedia Britannica are so clear, and make that type of furnace so distinctive from a recuperative or a regenerative furnace, that we can drop the word reverberatory as being not apposite to the gas business in the sense in which we are connected with it, viz.; gas used for city distribution, and this seems to justify dropping a further discussion of this word, and of this type of construction.

Not so, however, with the words recuperative and regenerative. Referring for a moment to "Die Gaserzeuger und Gasfeuerungen" by Ernst Schmatolla, edition 1901, pp. 66, 67 and 68, we find a general description of regenerators. In general his description comprises a chamber or set of chambers filled with fire-brick, through which the hot waste gases are passed until the checker work of fire-brick is heated, it being understood that this passage of gases takes place in one continuous direction during this heating process. After the regenerative chamber has attained a suitably high temperature, the flow of the hot gases through it is stopped, and gas or air is admitted into this chamber and flows through it in the opposite direction from that of the hot waste gases, and in this manner the air or gas is preheated. The process is described distinctly as an intermittent one, and the idea of reversal in direction of the hot waste gases, and the air or gas to be preheated, is also clearly brought forth.

We have still another reference on this question in the "Lehrbuch der Chemischen Technologie der Energien," by Hans v. Jüptner. This book of Jüptner's constitutes one of

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the most authoritative as well as one of the most recent publications on these subjects, not only in Germany but in the scientific world. Referring to the 1906 edition, Book I, Part 2, we find several clear and distinct definitions or ideas on the words "recuperative" and "regenerative." Here are some of these distinctions as set forth in Jüptner's work :—

Page 60. —"Recuperators" are defined as "preheaters."
"Regenerators" are defined as "storage places of heat."

Page 105. —In the chapter describing "Kinds of Heat Producers," Jüptner states as follows :—

"'Regenerators,' or storage places of heat, are so called because the material receiving the heat (checker work of fire-brick) gathers this heat from the products of combustion for a given period of time, in order to give it out again later on to the substance to be heated."

Page 135.—In chapter XIV, Jüptner treats of "Recuperators, Regenerators and Air Heaters," and here a further distinction of the words under discussion is introduced. Here these styles of construction have certain additional distinctive features added as follows: "Recuperators" are styled as those subject to continuous operation, while "regenerators" are stated as those subject to intermittent operation.

As I have already gone into this part of the subject at length I simply wish to add another line of thought concerning it which is offered by Mr. J. M. Rusby, of the United Gas Improvement Company of Philadelphia. The following extract from a letter I received from Mr. Rusby under date of July 17, 1907, covers the points he brings forth :—

"To regenerate means to redevelop. Thus apparently referring to sensible heat (in which form all waste heat is recovered in recuperation), its redevelopment from the latent heat of steam by condensation might be considered a regenerative process; also, its development from the latent heat of combustion of producer gas by burning is such; also (see 'Gas and Gas Making,' Encyclopedia Americana), a deep furnace which makes producer gas for subsequent burning at another part of the setting, is properly called a regenerative furnace.

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"From the foregoing, does it not rather seem that both the recuperative constant flow flues of the coal gas bench and also the brick-filled Siemens 'stove' should both be called recuperators, the word regenerative being reserved to only apply to furnaces which make producer gas with its stored latent heat of combustion, or regeneration of sensible heat, but is this occasional fact a warrant for giving it another name than recuperator? Since the words regeneration and recuperation have no relation whatever, it being possible for a furnace to possess one without the other, it seems that they should be kept carefully separate.

"The Siemens 'stove' might be called an intermittent recuperator, and the flues of the coal gas bench a continuous recuperator; more appropriate titles may suggest themselves to you.

"Present usage, however, even by the best writers, is not in entire conformity with the foregoing. In many cases, as you state, there is no effort at even consistency. One of the most careful writers whom we have happened to find (see Damour's 'Industrial Furnaces,' 1906, published by the Engineering and Mining Journal, New York City), appears to use these terms about as you suggest; thus, while he in his general treatment calls both the Siemens stove and the coal gas bench flues recuperators, he nevertheless thereafter practically separates them and calls the Siemens stove a regenerator (p. 238). He also alludes (p. 116) to the receiving of carbon dioxide by a furnace, and its conversion thereby into combustible carbon monoxide, etc., as a 'so-called' regenerative process; as to his precise practical use of this term regenerative, I must refer you to his book."

From the foregoing it appears that I may suggest the following definitions of the words "recuperative" and "regenerative," as applied to coal gas benches, and it is, of course, open to question as to whether the profession in general sees fit to adopt them. I wish to add, however, that the line of thought suggested by Mr. Rusby is very pertinent, and probably, in the strictest interpretation of the words and their

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meaning, he is correct. Owing, however, to the almost universal adoption of the word "regenerative," as describing the Siemens furnace, by the most careful and authoritative technical writers at home as well as abroad, I would hesitate to reject this meaning as being the incorrect one in the field of technology, whatever may be the etymological one.

RECUPERATIVE BENCH.

A recuperative bench is one in which one of the essential parts is a recuperator, or set of recuperators; whose function is the preheating of some substance, usually air, whether that be primary or secondary air, or both; such preheating being accomplished by continuous operation, in one direction of passage of the substance to be heated through a flue, or set of flues, and without reversal of direction, and without a transposition from one flue or set of flues to another flue or set of flues. The latter phase of the definition practically forces the additional statements that the transfer of heat takes place through the walls of the flue or flues, which walls in no sense of the word are to be considered as storing up heat, and the substance supplying the heat must in consequence be separated from the substance to be heated by the walls referred to, and in its turn must have one direction of passage through the flue or flues, and must not be transposed from one flue or set of flues to another. This might properly be called a continuous recuperator.

REGENERATIVE FURNACE.

A regenerative furnace, in the technical sense of the word, is one in which one of the essential parts is a flue or chamber, or set of chambers, which is used for the preheating of some substance, usually gas or air, or both; such preheating being accomplished by distinctly intermittent operation; the substance to be heated passing through such a chamber, or set of chambers, for a limited period of time; after which it is transposed to another chamber or set of chambers; the first chamber, or set of chambers, then having the substance supplying the heat introduced into it, for the purpose of storing up heat; after which the substance to be heated is again transposed into the first chamber or set of chambers, for the purpose of

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taking up the stored heat, and so on ad infinitum. One of the essential ideas is a distinct storing up of heat; another is the giving out, and absorbing of such heat by convection and radiation of such heat, and not by transmission of the heat through any substance, such as walls of flues. It follows, therefore, that the substance giving out, and the substance receiving the heat, can not occupy one chamber, or set of chambers, at the same time. I can not find that the reversal of flow is necessary to the technical correct understanding of the term, but such reversal of direction of flow of the two substances would probably be employed. This might more strictly be called an intermittent recuperator.

I will enter a plea right here that writers on these subjects be very careful of the terms they use, and if still better definitions are devised than the foregoing, so much the better for all of us.

A RATIONAL METHOD OF RATING OR CLASSIFYING RECUPERATIVE BENCHES, PARTICULARLY AS TO DEPTH OF FIRE AND AMOUNT OF RECUPERATION.

It has become customary among us all and among the manufacturers to speak of half, three-quarter, and full-depth recuperative benches, and it appears to me to be highly desirable to discard such terms, which upon close analysis can not be supported by good reason and argument, and adopt in their stead some rational method of rating benches which will satisfactorily and logically fill all requirements.

In a paper I wrote for the Ohio Gas Light Association for the 1903 meeting, I offered the following definitions of certain so-called types of benches:

"A full-depth recuperative bench is one in which both the primary and the secondary air is preheated.

"A half-depth recuperative bench is one in which the secondary air only is preheated."

I wish to state that these definitions now appear to me erroneous, and I wish to retract them right here.

To start with, it is easy to see how two manufacturers, for instance, could be bidding on a certain job of, say, so-called half-depth benches. Both might offer the same number and

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size of retorts, iron work and all that, but one might put in recuperators down to the level of the foundation, while another might stop them two feet above the grates. Both would be bidding on half-depth benches, but the competition would be wholly unfair, unless due allowance was made for this discrepancy.

It appears to me to be essential to state the primary objects to be accomplished in the design and construction of a recuperative bench. As I see them, these objects are:

First. To completely carbonize the maximum quantity of coal in the effective length of the retorts in the shortest possible period of time.

Second. To do this with the least possible cost (such as for bench fuel, labor, etc.).

The above considerations lead us to first consider the retort itself. Here we should endeavor to be able to properly carbonize as much coal as possible per unit of effective length of the retort in the shortest possible time. This, of course, requires a certain number of heat units per unit of time, and this in turn necessitates a certain producer gas capacity. Omitting for the moment the gas producer portion of the argument, I will try to show that there should be a certain recuperation capacity per unit of effective retort contents in any given recuperative bench.

RELATION OF EFFECTIVE RETORT CONTENTS TO RECUPERATION.

The greater the amount of coal carbonized per unit of effective retort contents, the greater is the amount of a given quality of producer gas that must be burned in a given length of time, and this necessitates in turn a greater recuperation capacity. This statement appears to me to be true, and from it there follows the conviction that there is probably an economical relation between effective retort capacity and effective recuperation capacity. Now, how should this relation be expressed?

It first occurred to me that the effective retort capacity should be the proper expression to use, but this may lead to erroneous conclusions, inasmuch as the shape of a retort may

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alter the relation of the interior surface to the cubical contents. It appears, therefore, that it would be wiser if we used both the effective cubical contents, and effective interior surface of the retorts, and expressed their relations to the effective recuperation surface. It appears to be somewhat puzzling to select the effective recuperation surface, but after study I would suggest that that surface of the recuperators which is in contact with the hot waste gases, and which has the incoming air on the opposite side of the wall, be adopted. In other words, I would not consider as effective the portion of the recuperator surface which touches the wall of the arch of the bench, nor any such surface which does not transmit heat directly through the material to the incoming, passing air on the other side of it. This may not be exactly the truest expression of effective recuperator surface, inasmuch as heat is undoubtedly transmitted through the walls in other directions than perpendicular to the surface of the wall; but by adhering to the method I have suggested, it will have the merit of uniformity, and will always enable comparisons to be made. I will use it thus in this discussion.

If, then, when we order or design benches, we will specify the relation between effective retort contents, effective interior retort surface, and effective recuperation surface, we should certainly be enabled to secure at least honest competition, and eventually we will find what is the economical relation between these qualities.

In as far as effective retort contents and effective interior surface of retorts are concerned, I will simply state my ideas on these points in connection with ordinary horizontal retorts. I would figure the effective portion of a retort as beginning at the interior of the front wall of the bench, and extending on the inside up to the joint between the back and the body of the retort. This omits figuring the back entirely, as it is usually bricked up solidly against the rear wall of the bench, and also omits that portion of the front end projecting into the front wall of the bench. The figuring of a through retort, or of vertical or inclined retorts, would be considered on a similar basis, but will not be treated in this paper.

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I am unable to state just what these relations should be at this writing, but have certain data regarding current practice which I herewith present. One company prominent in the manufacture of fire-brick products in the United States, who build many benches every year, have kindly given me their plans and figures on various types of benches, as follows:

SO-CALLED HALF-DEPTH BENCH OF SIX RETORTS.

Retorts, 16 in. x 28 in. x 9 ft. 0 in.
Effective length retorts 7 ft. 9 in.
Effective interior surface per retort, 6441 sq. in.
Effective interior surface per 6 retorts, 38646 sq. in.
Effective cubical contents per retort, 31577 cu. in.
Effective cubical contents per 6 retorts, 189462 cu. in.
Effective recuperation surface, 16034 sq. in.
Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 41.5%.
Ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 8.46%.

SO-CALLED THREE-QUARTER DEPTH BENCH OF SIX RETORTS.

Retorts, 16 in. x 28 in. x 9 ft. 0 in.
Effective length retorts, 7 ft. 9 in.
Effective interior surface per retort, 6441 sq. in.
Effective interior surface per 6 retorts, 38646 sq. in.
Effective cubical contents per retort, 31577 cu. in.
Effective cubical contents per 6 retorts, 189462 cu. in.
Effective recuperation surface, 22287 sq. in.
Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 57.7%.
Ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 11.75%.

SO-CALLED FULL-DEPTH BENCH OF SIX RETORTS.

Retorts, 16 in. x 28 in. x 9 ft. 0 in.
Effective length retorts, 7 ft. 9 in.
Effective interior surface per retort, 6441 sq. in.
Effective interior surface per 6 retorts, 38646 sq. in.
Effective cubical contents per retort, 31577 cu. in.

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Effective cubical contents per 6 retorts, 189462 cu. in.

Effective recuperation surface, 32174 sq. in.

Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 83.2%.

Ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 17%.

SO-CALLED FULL-DEPTH BENCH OF NINE RETORTS.

This particular bench contains 6 retorts 16 in. x 28 in. x 9 ft. 4½ in., and 3 retorts 16 in. x 26 in. x 9 ft. 4½ in.

Effective length of all retorts, 8 ft. 1½ in.

Effective interior surface of retorts is as follows:

Size, 16 in. x 28 in. x 8 ft. 1½ in. = 6753 sq. in. = 40518 sq. in. for 6 retorts.

Size, 16 in. x 26 in. x 8 ft. 1½ in. = 6490 sq. in. = 19470 sq. in. for 3 retorts.

Total effective interior surface = 59988 sq. in. for 9 retorts.

Effective cubical contents of retorts is as follows:

Size, 16 in. x 28 in. x 8 ft. 1½ in. = 33005 cu. in. = 198030 cu. in. for 6 retorts.

Size, 16 in. x 26 in. x 8 ft. 1½ in. = 31522 cu. in. = 94566 cu. in. for 3 retorts.

Total effective cubical contents = 292596 cu. in. for 9 retorts.

Effective recuperation surface = 32174 sq. in.

Ratio of effective recuperation surface to effective interior surface of all 9 retorts, 53.5%.

Ratio of effective recuperation surface in square inches to effective cubical contents of all 9 retorts in cubic inches, 11%.

These figures show nothing except an arbitrary relation. The extent to which recuperation is to be carried in order to secure the greatest commercial economy is, as far as I am able to determine, as yet unknown. I have knowledge, however, of recent installations in which I believe the recuperation has been applied to an extent never before attempted.

There is another aspect of recuperation which I wish to present for consideration, or rather a more forcible presentation of the reason or desirability for recuperation. I know of no better way to concisely and tersely present the matter than

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to quote from a letter I received from Mr. B. E. Chollar under date of July 15, 1907:

"Recuperation. Let us suppose, for illustration, that one-fifth of the heat from the furnace is absorbed by the retorts, and another is enough for the chimney, there remains three-fifths for possible recuperation. Now, if an area equal to the retort surface takes one-fifth, the absorbing surface for the three-fifths to be recovered should be at least three times as much as the retort area. In other words, if the above supposition should happen to be right, the maximum recuperator surface should be about three times the retort area. This area is for only one set of flues. To get the total of radiating and absorbing surface this area should be doubled. This is just one way of looking at the question. It is not a recommendation to be carried to the limit."

I believe Mr. Chollar brings out his point very clearly, and in your own minds you can compare his illustration with the figures from the manufacturers' standard previously quoted.

In some of my previous papers on this subject I referred to a paper written by Mr. Fred. Bredel, and read before the Western Gas Association in May, 1892, entitled, "The Advantages of Recuperative Furnaces in the Utilization of Heat."

I wish to again call attention to this paper. Almost all of the thermal calculations concerning standard recuperative bench operation are given therein, and, what is more, the variation of the specific heat of various gases at different temperatures is taken into consideration in the figures. Anyone who undertakes to delve into the mysteries of recuperative benches, should study this excellent paper by Mr. Bredel, and he will find that Mr. Bredel had it all figured out very well long ago, and that a great many of the more recent efforts in this direction are not nearly so good as Mr. Bredel's.

This same gentleman read a paper before the Ohio Gas Light Association in the same year, viz., 1892, entitled, "The Determination and Regulation of the Proper Proportions of Primary and Secondary Air and Steam in Regenerative Furnaces." In this paper Mr. Bredel arrives at the conclusion that the waste gases on leaving a good recuperator should not have a

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higher temperature than 350° to 360° C., or 650° to 680° Fahr. It may be that such figures are as good as we should strive to attain in commercial operation, but it looks to me as though there were some possibilities in carrying recuperation still further, even though the balance of the sensible heat which could be extracted from the waste gases was utilized in other ways than to preheat secondary air. I make this statement because the sensible heat in the waste gases is greater than can be taken up by the secondary air alone.

Before making any further reference to the proper amount of recuperation for any given retort installation, I will here outline the principal thermal considerations of a recuperative construction. Omitting the consideration of utilizing water or steam under the grates, and also losses by radiation, convection, opening of doors, ash, clinkers, etc., we have:

1. A given amount of fuel, say carbon, burns to CO_2, through a producer gas operation, and develops a certain high flame temperature, "A." The products of combustion, therefore, at first have a temperature "A," and pass around the retorts to the entrance of the recuperator, where they have a lower temperature "B."

2. The amount of heat, therefore, required to heat the retorts (omitting all losses) is measured by the drop in temperature of the products of combustion from "A" to "B," times the average specific heat of said gases between said temperatures.

3. The amount of available heat left in the products of combustion at the top of the recuperators, is measured by the drop in temperature from "B" to atmospheric temperature "C," times the mean or average specific heat of said gases between said temperatures "B" and "C," again omitting all losses.

If we should assume "C" = 20° C. and "B" = 1150° C., then the maximum available drop in temperature in the recuperators is 1130° C. As the amount of waste gases is greatly in excess of the amount of secondary air, and also because of the greater thermal capacity, it appears to me impossible to utilize all of the available heat between the temperatures "B" and "C" for preheating the secondary air, and there are certain physical conditions which make an attempt

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at preheating the primary air to any great extent considerable of a question.

I must say that the ideal way to construct benches appears to me to have separate continuous gas producers serving a stack of benches, using as much of the sensible heat of the waste gases as possible for preheating the secondary air, and the balance might be applied for preheating the primary air, the fuel itself, or possibly in still other ways.

I must also say that I am unable to give the commercially best amount of recuperation surface for preheating secondary air as related to any given retort installation, but am of the opinion that, if anything, we use too little rather than too much. I would also say that the figures of the particular manufacturer I cited are such that I believe I would specify still greater percentages than those quoted. The whole art is still so indefinite that I believe we shall only gradually come to a correct understanding of the proper recuperator relations.

I will not endeavor to cover such practical considerations as sizes of flues, leakage between the waste gas and air flues, thickness of walls, change of direction of flues, etc., because these form special features of design which I did not intend to consider. For heat transmission through firebrick, see diagram by Mr. Fred Bredel, page 137, Proceedings of Western Gas Association, 1892 to 1895 inclusive. I believe that the functions of a recuperator can be outlined briefly as follows:—

First. The length of time accorded to the waste gases to give off their heat.

Second. The amount of heating surface, thickness of division walls, and as little friction loss as possible in the passage of the waste gases through the flues.

Third. The heat accumulative capacity of the recuperator—that is, a heavy recuperator will act as a storage reservoir of heat, and cause less heat fluctuations than a light one.

Before leaving this portion of the subject entirely I wish to insert some valuable comparative data kindly furnished to me by Mr. A. H. Strecker, Engineer, The Public Service Corporation of New Jersey, concerning full-depth benches. Mr. Strecker figures recuperation surface just as I do, but figures the effective length of a retort from the face to the inside of

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the back, which I think is a little liable to result in confusion. He does not include the back of the retort, however.

(Data by Mr. Strecker.)

Type of Furnace.	Heating Surface of Recuperator in Square inches.	Ratio of Recup. Surf. to Surface of Retorts.
Klöenne	30720	33.9%
Parker-Russell	30240	33.3%
Newark	37152	41.1%
Average	32704	36.1%

The recuperators cited in these figures occupy practically the whole space between exit flues which are situated on basement floor level, and are about nine feet high. He states the lower smoke flue temperature runs from 500° Fahr. to 600° Fahr. In the Klöenne and Newark benches the heat of the flue gases is made further use of to evaporate water in the ash pan.

DEPTH. GRATE AREA.

The actual depth of the furnace and of the fire is another matter closely related to a proper bench design. Since I am attempting to discuss recuperative benches only, all matters relating to free fire benches will be omitted.

The fundamental idea of the furnace is simply that it is a gas producer, and usually there is air and some water vapor admitted under the fire. The oxygen of the air and of the water appear above the fire, combined with carbon in the form of carbon monoxide, the hydrogen of the water as hydrogen, while the nitrogen of the air passes through unchanged. I will discuss these reactions a little later on in the paper, and for the purposes of this immediate discussion it is only a question of a few general principles which are involved.

In general the elementary principles governing the shape of a producer have been enumerated in my paper before the Ohio Gas Light Association in 1903. A producer ought theoretically to be circular in cross section, because the circle is that geometrical figure which has the greatest area for the least length of developing line. On account of practical considerations a rectangular cross section is usually adopted, and this in turn should be as wide as possible, or in other words ap-

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proach a square cross section, for the reason that a square is the geometrical rectangular figure which has the least perimeter for a given area, less than any rectangle.

Under a bench a rectangular producer cross section is practically necessary, but for separately fired producers I most emphatically state that a circular cross section should be the best or at least a square one.

Now, the thermo-chemical functions which a gas producer is called upon to fulfill require for one thing a minimum depth of fire. The question of velocity or, what is the same thing, the question of the finite length of time required to produce the reactions mentioned, will be omitted for the moment. It seems to be the general opinion that a minimum fire-depth of about three feet under reasonable velocity conditions will allow these reactions to take place. As authority for such a statement I quote:

Letter from Mr. Fred Bredel to me, June 28, 1907.

See Schmatolla, "Die Gaserzeuger und Gasfeuerungen."

Certain of our fire clay products manufacturers evidently believe that even a slightly less depth than three feet might be satisfactory. I believe, however, that deeper fires would be preferable, although they might be somewhat difficult to secure in the so-called half-depth benches.

In regard to the question of depth, I will quote in full from a letter I received from Mr. Roger W. Polk of St. Louis, under date of July 2, 1907, as follows:—

> "The terms (referring to half-depth, etc.) adopted by the bench manufacturers would be all right if they would all use a certain height of arch for a certain term of bench. For instance, I consider a half-depth bench one in which the distance from the grate bars to the crown of the furnace arch is 36 in.; a three-quarter depth bench one in which this same dimension is 54 in., and a full-depth bench 72 in. These are absolute measurements, and the three-quarter depth bench is exactly half-way between a half-depth and a full-depth bench. It is understood, of course, that the recuperators extend down to a level with the top of the ash pan in all cases,

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otherwise you might have a half-depth recuperator with a full-depth furnace.

"It would not be necessary to take the measurement from the grate bars to the furnace arch, but if manufacturers would take some similar dimension there would be no chance of a misunderstanding. The distance from the bottom of the bottom retort in a bench of 6's to the crown of the arch inside is practically always the same whether the bench be a half-depth, three-quarter depth, or full-depth. Therefore, if the manufacturers would assume a distance from the top of the ash pan to the bottom retort for a half-depth bench, and make this distance double for a full-depth bench, and half-way between the two for a three-quarter-depth bench, there could be no possible misunderstanding of the terms.

"The depth of a bench, however, has always referred to a height of some kind, and in my opinion has nothing whatever to do with the preheating of the primary or secondary air, except that it must be understood that the recuperators occupy the full available space provided for them, and that there is not a foot or two of red brick or some other filling material put at the bottom of the recuperators where this space could be occupied by the recuperators proper.

"In regard to the preheating of the primary air in a bench, it has been my experience that it is not a good practice, as it has the same effect on a furnace that superheated steam has in a water gas machine, that is, to form clinkers. Preheating the primary air simply carries so much sensible heat into the furnace, where it should be the aim to keep the temperature of the fire down.

"There is not much difference in the half-depth benches of different manufacturers, they all being about 12 ft. 2 in. or 12 ft. 3 in. from the ash pan to the crown of the arch inside; but, as you are well aware, when you get into three-quarter and full-depth benches there are all sorts and kinds of dimensions. As long, however, as they have come to a pretty good understanding of what a half-depth bench is, it seems to me that it would be a good

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plan to call a full-depth bench twice this depth, and a three-quarter depth exactly half-way between—that is, in respect to the height from the grate bars to the furnace arch, ash pan to the floor line, or ash pan to the bottom retort.

"There are some benches that have no furnace arch, the same as the Weber bench. It, therefore, might be advisable to assume a dimension from the ash pan to the bottom of the first retort, if the bench be a recuperative bench, no matter whether it is a bench of 4's, 6's, 8's or 9's."

From the above extract from Mr. Polk's letter it will be seen he appears to favor absolute dimensions for benches of various depths. At first this plan appeared the most feasible to me, but after further study I believe I can suggest a better and more desirable rating, and this is largely the outcome of a suggestion by Mr. Fred Bredel.

The real point at issue as far as "depth" is concerned is the actual working effective depth of the fire itself, at least it so appears to me. Then why not work out a rating of benches on this basis?

As a general suggestion I may say that a fire four feet deep at the foot of the slope of fuel (for there usually is at least a slight slope) directly after firing will reduce to, say, about three feet just before the next firing. Three feet depth still allows the proper reactions to take place. As a fire for best working should be as nearly level as possible, I believe it would be more nearly correct to use the average effective depth of the fire just before firing up, and the maximum average effective depth that could be secured in the particular design under consideration.

As far as depth is concerned I offer the following suggestions as to rating recuperative benches. A *shallow producer* recuperative bench is to have an average effective fire depth just before firing of not less than three feet, and a maximum average effective fire depth of not over five feet.

A *medium depth producer* recuperative bench is to have an average effective fire depth just before firing of not less than

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five feet, and a maximum average effective fire depth of not over seven feet.

A *deep producer* recuperative bench is to have an average effective fire depth just before firing of not less than seven feet, and a maximum average effective fire depth of not over ten feet.

Anything deeper than ten feet could be called special. By effective fire depth I mean the distance from the top of the grate bars to the top of the fuel, or the straight line distance from any opening between water pans, or elsewhere to the nearest upper surface of the fire, whichever is the least distance. I realize these are arbitrary divisions, but they have this in their favor—they can not be misunderstood.

As far as grate area is concerned I will give the grate areas used by the manufacturer whose figures on recuperator surface and retort contents I have previously quoted.

So-called half-depth bench 6's—7.82 sq. ft.
" three-quarter " 6's—8.47 "
" full depth " 6's—8.82 "
" " " 9's—13.90 "

This manufacturer figures the grate as the area of the throat of furnace. He takes a straight line from the brick wall in the front of the furnace just above the plates, to the nearest point of the brick work in the back of the furnace. This he calls the length of the grate. For the width he takes the width at the grate bars and the width in the upper part of the fire, and averages these dimensions and calls that average the width. This particular width multiplied by the particular length aforesaid gives the grate areas as stated above.

Grate area is simply a question of how much fuel can readily and in good practice be converted into producer gas per square foot of grate per hour. Owing to recent applications of return flue gases under the fires, it may be possible to burn much larger quantities of fuel per square foot of grate area per hour than formerly. I believe from 8 to 12 pounds of coke per square foot has been considered fair practice, but this bids fair to be increased very much. It appears to me to be wise to allow a reasonable amount of safety, and without considering the re-

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urn flue gas scheme I would say that it would be safe to figure 8 pounds of Pittsburgh gas coal per square foot of grate per hour.

At one time I had it in mind to figure 8 pounds pure carbon per square foot of grate per hour, but owing to the variation in composition of fuels, especially as regards ash contents, it does not seem right to put it on this basis. I would treat fuels as classes in such work, such as cokes, bituminous coals of certain grades, hard coals, etc., and secure a certain general figure for each class.

With all the foregoing matters in mind then I would classify recuperative benches as follows:

There would be three general classes:—

First, shallow producer recuperative benches;

Second, medium depth producer recuperative benches;

Third, deep producer recuperative benches.

For each of the three classes I would give the following definitions:

First, a *shallow producer* recuperative bench is one having an average effective fire depth just before firing of not less than three feet, and a maximum average effective fire depth of not over five feet. In such a bench the ratio of effective recuperation surface to effective interior surface of all retorts is to be not less than 40%. Also in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts in cubic inches is to be not less than 9%. The grate area to be figured on the kind of fuel used.

Second, a *medium depth producer* recuperative bench is one having an average effective fire depth just before firing of not less than five feet, and a maximum average effective fire depth of not over seven feet. In such a bench the ratio of effective recuperation surface to effective interior surface of all retorts is to be not less than 50%. Also in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts in cubic inches is to be not less than 10%. The grate area to be figured on the kind of fuel used.

Third, a *deep producer* recuperative bench is one having an average effective fire depth just before firing of not less than

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seven feet, and a maximum average effective fire depth of not over ten feet. In such a bench the ratio of the effective recuperation surface to effective interior surface of all retorts is to be not less than 60%. Also in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts is to be not less than 11%. The grate area to be figured on the kind of fuel used.

Now I wish to say right here that I realize as well as any one that the figures in the foregoing definitions are arbitrary. Further, the grate area, for any given class of fuel, can probably be expressed as a relation to effective retort contents. Even if, as I expect, practice, further study, and experimenting, shall determine what figures are commercially the correct ones to be inserted in place of those I have given, yet I feel that these definitions point the way to a rational bench classification more satisfactory than any I have so far seen. At least we can reasonably hope that, in the course of time, still better and more simple definitions will result. I feel quite sure that we all agree that something better than the present ratings of benches is highly desirable, and we should all try to find out more about the subject. Very little really accurate and valuable knowledge and facts seem to be available at this date.

CERTAIN FEATURES OF THE THERMO-CHEMICAL PRINCIPLES OF GAS PRODUCER OPERATION.

Almost all of the writings on the subject of gas producers, as well as a great many patents, are filled with certain chemical reactions which have been used so much and so often that they have become stereotyped, so to speak. A great many people probably believe them just because they are stated over and over again by almost everybody.

This is the case with producer gas chemistry, and I wish to call attention to the facts as stated by some of the most eminent scientists of the day, that we are not sure of these things as yet, and universal agreement concerning them is far from being reached. Therefore all positive statements, and even the wording of such reactions in patents, are to be taken with several grains of caution.

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The ordinarily accepted thermo-chemical reactions in connection with the action of air in gas producers are to the effect that air on coming into contact with carbon at the bottom of the fire first unites to form carbon dioxide, and this carbon dioxide, on passing up through the incandescent fuel, is reduced to carbon monoxide by the addition of an atom of carbon, all as expressed in the following equations:

$$C + O_2 = CO_2, \text{ exothermic reaction.}$$
$$CO_2 + C = 2\,CO, \text{ endothermic reaction.}$$

Now, if water vapor be present, it is ordinarily believed that this water vapor dissociates, separating into hydrogen and oxygen, an endothermic reaction, the hydrogen passing on through the fire unchanged, while the oxygen first unites with carbon to form carbon dioxide, and this subsequently reduces to carbon monoxide, all as shown in the following equations:

$$H_2O = H_2 + O, \text{ endothermic reaction;}$$
$$C + O_2 = CO_2, \text{ exothermic reaction;}$$
$$CO_2 + C = 2\,CO, \text{ endothermic reaction.}$$

Now, let us see how these reactions and subjects are viewed by people who are probably careful in their investigations and whose opinion is worthy of serious consideration. I will first quote from "Die Gaserzeuger und Gasfeuerungen," by Ernst Schmatolla, edition 1901.

On page 4 of this book we have an explanation of the formation of carbon monoxide as follows:

> "The incandescent carbon acts upon the carbon dioxide formed below, and which is rising upwards, in a reducing manner, in which carbon monoxide is formed by the addition of carbon to carbon dioxide as follows:
>
> $$CO_2 + C = 2\,CO.$$
>
> "Besides this, carbon monoxide is also formed through incomplete combustion as in this equation:
>
> $$C + O = CO.$$
>
> "This incomplete combustion can be explained, that in the upper layers of the fire there is only a very insufficient quantity of oxygen, not sufficient to produce carbon dioxide."

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Note the statement that carbon monoxide is formed directly. Quoting the same author again on page 11, we have the following:

"Carbon monoxide gas is formed partly through incomplete combustion of carbon as per the equation:

$$C + O = CO.$$

"Also partly owing to the action of incandescent carbon upon carbon dioxide as follows:

$$CO_2 + C = 2\ CO.$$

"The first process is one of oxidation, the latter of reduction; in the first process heat is developed (exothermic reaction), in the latter heat is absorbed (endothermic reaction)."

The same author treats the reactions caused by the introduction of water vapor under a fuel bed on pp. 11 and 12.

"As already stated in the first chapter, incandescent carbon dissociates water vapor. If the temperature of the fire is high, viz.: greater than 1000 degrees (Cent.), hydrogen and carbon monoxide are formed by the action of incandescent carbon upon water vapor after the formula:

$$H_2O + C = H_2 + CO.$$

If the temperature at which the reaction takes place is lower, especially if it drops below 800° (Cent.), the reaction between water vapor and carbon follow as per this equation:

$$2\ H_2O + C = 2\ H_2 + CO_2.$$

"As carbon dioxide is not a combustible gas, the producer should be operated so that the process indicated by the former equation takes place."

Schmatolla also gives the same reactions on p. 39 while explaining the production of so-called Dowson gas, and again on p. 40 while presenting the reactions taking place in a water gas generator, in both cases laying particular stress upon the statement that the critical temperature is about 1000° (Cent.).

I should consider as much more authoritative, as well as being more recent, the explanation of these thermo-chemical reactions as given by Professor Hans v. Jüptner in his "Lehrbuch der Chemischen Technologie der Energien," as

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given in the 1905 edition in Vienna in Book I, Part 1. I wish to apologize for introducing such a lengthy quotation in a paper already much too long for an Association paper, but I feel that the value of this data given us by Professor Jüptner is so great, and so little of it is known in this country apparently, that it would be a shame to withhold it, especially as it will undoubtedly be of great assistance to us in the study of the thermo-chemistry of our business.

QUOTATION FROM JÜPTNER'S WORK—

INCOMPLETE COMBUSTION.

"The complete combustion of the fuels used in ordinary thermo-chemistry operation results in carbon dioxide and water. If the chemical composition of the fuel is known, it is an easy matter to calculate the amount of oxygen theoretically required to obtain complete combustion. This amount is denoted as the theoretically necessary amount of oxygen for complete combustion.

"The average composition of dry air free from carbon dioxide is:

	By Vol.	By Weight.
Oxygen,	21%	23%
Nitrogen,	79%	77%
	100%	100%

and therefore it is an easy matter to compare the theoretical amount of air required to cause complete combustion.

"In reality, however, this theoretical amount of air is not sufficient, and it becomes necessary to use an extra amount of air, the quantity of which is expressed in a proportion of the theoretical amount of air required.

"The cause of this phenomenon is to be found partly in the mixing of the gases and the air for combustion, this being very difficult and in many cases very incomplete, and also partly due to the appearance of incomplete reactions.

"An incomplete combustion, therefore, can furnish different products as the following example will show:

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$$C + O \begin{cases} CO, \text{ or} \\ \frac{1}{2}(CO_2) + \frac{1}{2} C \end{cases}$$

$$C_2H_4 + O_4 \begin{cases} 2\,CO_2 + 2\,H_2, \text{ or} \\ 2\,CO + 2\,H_2O \end{cases}$$

$$C_2H_4 + O \text{ result in } \begin{cases} CO + CH_4, \text{ or} \\ CO + C + 2H_2, \text{ or} \\ C_2H_2 + H_2O \end{cases}$$

"The number of various reactions that can appear simultaneously, and therefore influence each other, is frequently very large. It is entirely dependent on the conditions under which the reactions take place; the same is the case with the amount of the products formed by these reactions. These phenomena obey certain laws, as follows:

"In all these cases a 'chemical equilibrium' is spoken of, which is dependent on certain conditions, the so-called 'conditions of equilibrium.'

"Such conditions of equilibrium are: temperature, pressure, electrical condition, the reciprocal proportion of the existing part of the element or 'the concentration.'

"When these conditions of equilibrium change, a change takes place in the condition of equilibrium itself in one sense or another, and according to the following qualitative law first formulated by Henry Le Chatelier. Every change of any one factor of equilibrium (or stability) produces a change in the system in that direction in which that particular factor experiences a change in the opposite sense.

"This proposition becomes plainer when we resolve it into the following one.

"1. Each increase in temperature causes a change, which has the tendency to lower the temperature of the system (endothermic reaction) and the reverse (exothermic reaction).

"For example:

"a.) Dissociation.

$$CO_2 \longrightarrow CO + O - 68.2 \text{ Cal.}$$
$$H_2O \longrightarrow H_2 + O - 58.2 \text{ Cal.}$$

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"In both these reactions heat is absorbed. Therefore, they are both caused and promoted also by increase in temperature.

"In opposition to this the reaction,

$$2\ CO \longrightarrow C + CO_2 + 42.0\ Cal.$$

in which heat is liberated, is promoted by a lowering of the temperature. Carbon monoxide will therefore be more stable at high temperatures. This reaction in the presence of platinum, iron, and especially nickel, takes place under approximate perfect diffusion, completely in the neighborhood of 300° C.

"b.) Incomplete Reactions:

$$CO_2 + H_2 \longrightarrow CO + H_2O - 10\ Cal.$$
$$CH_4 + CO \longrightarrow C_2H_2 + H_2O - 39\ Cal.$$

"In both reactions heat absorption takes place, therefore they are caused or promoted by increase in temperature. With lower temperature there will be present more $CO_2 + H_2$ or more $CH_4 + CO$; with higher temperature however more $CO + H_2O$ or more $C_2H_2 + H_2O$.

"The reverse conclusions are applicable for the example in the reactions.

$$CO + H_2O \longrightarrow CO_2 + H_2 + 10\ Cal.$$

"Lower temperatures are more favorable to this reaction.

"2. Every increase of the external pressure causes a change in the equilibrium, which reduces the pressure, and *vice versa*.

"Example:

"a.) Dissociation.

$$2\ CO_2 \longrightarrow 2\ CO + O_2$$
$$2\ H_2O \longrightarrow 2\ H_2 + O_2$$

"Through the dissociation of CO_2 or H_2O the volume (or with constant volume, the pressure) is increased by half. The dissociation, therefore, will increase with a decreasing pressure, but decrease with an increasing pressure.

"b.) Incomplete Reaction.

$$C_2H_2 + H_2 \longrightarrow CH_4 + C.$$

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"The volume of the solid carbon is so small that it may be neglected; furthermore, C does not appear at all as a gas, but the volume (or with constant volume the pressure) of the CH_4 produced is only half as large as that of the original mixture of C_2H_2 and H_2. Increasing pressure is therefore conducive to the progress of the reaction. This appears plainly in an explosion in closed vessels, where the amount of CH_4 and C increases with the pressure.

"The equilibrium:

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

is independent of the pressure when H_2O appears as steam, because the volume on both sides is the same; and because the volumes are equal, the pressures are necessarily equal.

"The reaction:

$$2\,CO = C + CO_2$$

is reduced by decreasing pressure, because the volume and also the pressure of CO_2 is only half as great as that of 2 CO.

"3. Each increase in concentration of a body in any system causes a change in the condition of equilibrium, by which a certain amount of this body disappears, and *vice versa*.

"The quantitative expression for the relation between the chemical equilibrium and the conditions of equilibrium (factors of equilibrium) varies, according to whether we refer to equilibrium at a certain temperature or generally to equilibrium at any temperature. In the first case—that is, for isothermic equilibrium, the law of mass is applicable; for the second common case the Van't Hoff equation (for volumetric concentration) or the Le Chatelier equation (for numerical concentration).

"In cases where gas mixtures are concerned, the last form is preferable for the reason that the numerical concentration follows directly from the composition of the gases in per cent. by volume.

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"In the following we will consider an example that has especial interest for the thermo-chemical engineer.

"The dissociation of carbon dioxide:

"Carbon dioxide dissociates at high temperatures according to the equation:

$$CO_2 \rightleftharpoons CO + \tfrac{1}{2}(O_2).$$

"The general expression for Le Chatelier's formula is:

$$\frac{1}{R}\int \frac{Q_T dT}{T^2} + (N'' - N') \text{ l. } P + \Sigma n_2 \text{ l. } C_2 - \Sigma n_1 \text{ l. } C_1 = \text{Constant.}$$

"In this formula:

Q_T = amount of heat due to reaction at temp. T.

P = the pressure under which the system exists.

N'' and N' = the number of molecules existing on the right side and left side of the reaction.

"n_1 and n_2 also C_1 and C_2 = that number of molecules, or rather the concentration of the various bodies appearing in the reaction, where the indices 1 and 2 refer to the original system and final system.

"If, to simplify the computation, we use the common log. instead of the natural log. and putting $\frac{1}{R} = 500$, we can write our general expression:

$$500\int \frac{Q_T dT}{T^2} + 2.3026\,(N'' - N') \log. P + 2.3026\,(\Sigma n_2 \log. C_2 - \Sigma n_1 \log. C_1) = \text{Constant.}$$

Now we have

$$N'' - N' = 1.5 - 1 = 0.5.$$

and

$$\Sigma n_2 \log. C_2 - \Sigma n_1 \log. C_1 = \log. \text{Constant} = \log. \frac{(\bar{C}_{CO})\,(\bar{C}_{O_2})^{\frac{1}{2}}}{(\bar{C}_{CO_2})}$$

Making the total concentration of the system after equilibrium has taken place = 1, we have,

$$\bar{C}_{CO_2} + \bar{C}_{CO} + C_{O_2} = 1.$$

"Assuming no superfluous oxygen exists we have from the reaction

$$\bar{C}_{O_2} = \frac{1}{2}\,\bar{C}_{CO} \qquad (2).$$

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"Assuming x = the relation between the dissociated carbon dioxide (*i. e.*, the resulting carbon monoxide) and that amount of CO_2 which would be present if no dissociation had taken place that is $\bar{C}_{CO} + \bar{C}_{CO_2}$ = the coefficient of dissociation, then we have,

$$x = \frac{\bar{C}_{CO}}{\bar{C}_{CO} + \bar{C}_{CO_2}} \qquad (3)$$

"From equations (1) and (2) it follows:

$$\bar{C}_{CO_2} + \frac{3}{2}\bar{C}_{CO} = 1;$$

$$\bar{C}_{CO_2} = 1 - \frac{3}{2}\bar{C}_{CO};$$

therefore,

$$x = \frac{\bar{C}_{CO}}{1 - \frac{3}{2}\bar{C}_{CO} + \bar{C}_{CO}} = \frac{\bar{C}_{CO}}{1 - \frac{1}{2}\bar{C}_{CO}}$$

from this follows further:

$$x - \frac{x}{2}\bar{C}_{CO} = \bar{C}_{CO}$$

or,

$$\bar{C}_{CO} = \frac{x}{1 + \frac{x}{2}} = \frac{2x}{2 + x}$$

$$\bar{C}_{O_2} = \frac{x}{2 + x}$$

and:

$$\bar{C}_{CO_2} = 1 - \frac{3}{2} \cdot \frac{2x}{(2 + x)} = \frac{2(1 - x)}{(2 + x)}$$

"By substituting these three values we have,

$$\log. \text{Constant} = \log. \frac{(\bar{C}_{CO})\ (C_{O_2})^{\frac{1}{2}}}{(C_{CO_2})}$$

$$= \frac{x^{3/2}}{(1 - x)\ (2 + x)^{\frac{1}{2}}} \qquad (30)$$

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"For determining the constant the following observations made by Henry Saint-Claire-Deville will serve:

$$P = 1 \text{ atm.}$$
$$T = 3000 + 273 = 3273$$
$$X = 0.40$$

"If we assume with Le Chatelier the amount of heat due to the reaction $CO + O \longrightarrow CO_2$ as independent of the temperature, which is, strictly speaking, not correct, but nevertheless permissible for first approximation, and take $Q = 68.2$ Cal., we have,

$$500 \int \frac{68.2 dT}{T^2} + 1.1513 \log. P. + 2.3026 \log. \frac{x^{5/2}}{(1-x)(2+x)^{1/2}} = \text{Constant.}$$

or, because for $P = 1$ atm.; $\log P = 0$.

$$\text{Constant} = -\frac{500 \times 68.2}{3273} + 2.3026 \log. \frac{(0.4)^{5/2}}{0.6\,(2.4)^{1/2}} = -11.7192$$

"Therefore,

$$-\frac{34100}{T} + 1.1513 \log. P - 2.3026 \log. \text{Constant} = -11.7192$$

or,

$$\log. \text{Constant} = \left(\frac{34100}{T} - 11.7192 - 1.1513 \log. P.\right) \frac{1}{2.3026}$$
$$= \frac{14809}{T} - 5.0895 - 0.5 \log. P.$$

"From this Le Chatelier has calculated the following values of x.

Temperature °C	Pressure in Atmospheres.					
	0.001	0.01	0.1	1	10	100
1000	0.007	0.003	0.0013	0.0006	0.0003	0.00015
1500	0.07	0.035	0.017	0.008	0.004	0.002
2000	0.40	0.125	0.08	0.04	0.03	0.025
2500	0.81	0.60	0.40	0.19	0.09	0.04
3000	0.94	0.80	0.60	0.40	0.21	0.10
3500	0.96	0.85	0.70	0.53	0.32	0.15
4000	0.97	0.90	0.80	0.63	0.45	0.25

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"The results of these computations coincide with the observations which have been made at about 1500° C on the density of carbon dioxide.

PRODUCER OR AIR GAS.

"If a limited amount of air is permitted to pass through a layer or bed of pure carbon (in practice charcoal or coke) incomplete combustion takes place—that is, carbon monoxide is formed from the influence of the oxygen on the incandescent carbon:

$$C + \frac{1}{2}(O_2) = CO.$$

"Beginning with the nearly correct assumption that air contains one molecule of oxygen to four molecules of nitrogen, we can write our reaction as follows:

$$C + \tfrac{1}{2}(O_2) + 2\,N_2 = CO + 2\,N_2$$

"We therefore produce, according to the above reaction, a gas that theoretically contains, to one molecule of CO, two molecules of N_2; and its composition would have to be

	By Vol.
CO	33.3%
N	66.7%

Upon combustion this gas should furnish for each 22.42 liters under constant volume $0.333 \times 67.9 = 22.61$ Cal. Under constant pressure $22.61 + 0.5 \times 0.54 = 22.88$ Cal. Therefore its heating value (constant pressure) would be per 1 cbm.

$$\frac{22.88 \times 1000}{22.42} = 1020.5 \text{ Calories.}$$

The heating value of one gramme of gas results as follows: According to the reaction the gas contains per one gramme-atom of carbon.

12 grm. carbon
16 grm. oxygen } 28 grm. carbon monoxide
$4 \times 14 = 56$ grm. nitrogen

Total, = 84 grm.

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"As 84 grm. of the gas contain 3 molecules ($CO + 2\ N_2$) 22.42 liter of the gas (at 0° C. and 760 mm. Barometer) contain $\frac{84}{3} = 28$ grm. and 1 grm. of the gas therefore develops $\frac{22.88}{28} = 0.817$ Cal.

"The previous reaction only takes place at very high reaction temperatures. With low reaction temperatures a second reaction appears and takes place simultaneously with the other, and in the more apparent manner, the lower the reaction temperature drops, namely the reaction

$$C + O_2 = CO_2$$

or if we permit air to act instead of oxygen

$$C + O_2 + 4\ N_2 = CO_2 + 4\ N_2.$$

"For every temperature (and every pressure) there exists between these two reactions a certain definite relation of equilibrium, which we will now study.

"If we subtract the equations

$$C + O_2 = CO_2$$

and

$$2C + O_2 = 2\ CO$$

from each other we obtain the equation

$$2\ CO = CO_2 + C$$

which represents a reaction that actually takes place at not too high temperatures and defines the relation at which the first two reactions appear simultaneously. The reaction

$$2\ CO \rightleftharpoons CO_2 + C$$

is reversible; that is, while pure carbon monoxide gas within certain limits of temperature dissociates into carbon dioxide and carbon, pure carbon dioxide under the same conditions dissociates solid carbon to carbon monoxide, thus simultaneously being reduced to carbon monoxide. Therefore an equilibrium is established between carbon monoxide and carbon dioxide and carbon that is dependent on the temperature and the concentration, *i. e.*, the gas pressure.

"As two volumes of the CO form only one volume of CO_2, the reaction taking place in the sense of our equa-

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tion reading from left to right under a decrease in volume, an increase of pressure would promote the formation of CO_2, whereas a decrease in pressure would promote the formation of CO. If in the producer we therefore desire to generate a gas very rich in CO, we should not admit the blast (primary air) under too high a pressure.

"To ascertain the influence of the temperature on the equilibrium, we must know the amount of heat due to the reaction. This we accomplish (for 18° C) in the following manner:

$C + O_2 = CO_2$		94310 Cal.
$2\,(C + O) = 2\,CO$	$2 \times 26700 =$	53400 Cal.
$2\,CO = CO_2 + C$		40910 Cal.

that is, the decomposition of carbon monoxide into CO_2 and C takes place with a development of heat (exothermic). Therefore an increase in temperature will promote the production of carbon monoxide, whereas a decrease in temperature, however, is not advantageous to its formation. From this we can see offhand that we get a better gas—that is, a gas richer in CO—the higher the temperature of the producer.

"All these considerations refer to the condition of equilibrium. Whether this condition is actually reached in practical operation or not, is dependent on several conditions (such as depth of material, porosity of same, blast velocity, etc.). In any case it is not only important from a standpoint of producer theory, but also from a practical operating condition, to know the various relations of this equilibrium, as it is only possible to get a good basis for comparison by being able to secure the results obtained from practical operation under corresponding theoretical conditions of equilibrium.

"It would carry us too far to go further into the details of securing such results, as this has been discussed thoroughly at other places (Jüptner "Lectures on the Theory of Generator and Water Gas," Ahrens "Collection of Chemical and Chemical-Technical Lectures"). In this manner we obtain the following information regard-

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ing the ideal composition of producer gas at various temperatures and pressures.

"A. Ideal composition of producer gas, generated with pure oxygen.

Blast Press	1 atm.		2 atm.		3 atm.		4 atm.	
Composition in % by Vol. at Temperature of	CO	CO_2	CO	CO_2	CO	CO_2	CO	CO_2
227° C 500° abs.	0.004	99.996	0.0028	99.9972	0.0023	99.9977	0.002	99.998
327° " 600° "	0.123	99.877	0.087	99.913	0.0711	99.9289	0.061	99.939
427° " 700° "	1.427	98.573	1.011	98.989	0.826	99.174	0.716	99.284
527° " 800° "	8.794	91.206	6.303	93.697	5.177	94.823	4.499	95.591
627° " 900° "	32.542	67.458	24.809	79.191	20.408	79.592	17.945	82.055
727° " 1000° "	70.35	29.65	58.705	42.295	51.788	48.212	47.017	52.983
827° " 1100° "	92.75	7.25	87.198	12.802	82.72	17.28	78.987	21.013
927° " 1200° "	98.445	1.555	97.00	3.00	95.65	4.35	94.315	5.685
1027° " 1300° "	99.50	0.50	99.00	1.00	98.97	1.03	98.67	1.33

"Figure 82 shows the contents of this table in diagrammatic form.

"B. Ideal composition of producer gas generated with dry atmospheric air.

Temperature of Gasification		Partial pressure of CO + CO_2 in atm.	Composition in % by Vol.		
t°C	T°abs.		CO_2	CO	N_2
		Blast Pressure = 1 atm.			
227°	500°	0.21	21.00		79.00
327°	600°	0.21	21.00		79.00
427°	700°	0.2145	20.31	1.14	78.55
527°	800°	0.24	16.40	7.60	76.00
627°	900°	0.29	8.75	20.25	71.00
727°	1000°	0.334	2.14	31.26	66.60
827°	1100°	0.344	0.47	33.93	65.60
927°	1200°	0.346	0.14	34.46	65.40
1027°	1300°	0.3465	0.01	34.65	65.35
		Blast Pressure = 2 atm.			
227°	500°	0.42	21.00		79.00
327°	600°	0.42	21.00		79.00
427°	700°	0.428	20.39	1.01	78.60
527°	800°	0.446	17.48	5.82	76.70
627°	900°	0.555	10.66	17.09	72.25
727°	1000°	0.6535	3.12	29.56	67.32
827°	1100°	0.6865	0.59	33.74	65.67
927°	1200°	0.692	0.16	34.44	65.40
1027°	1300°	0.693	0.09	34.56	65.35

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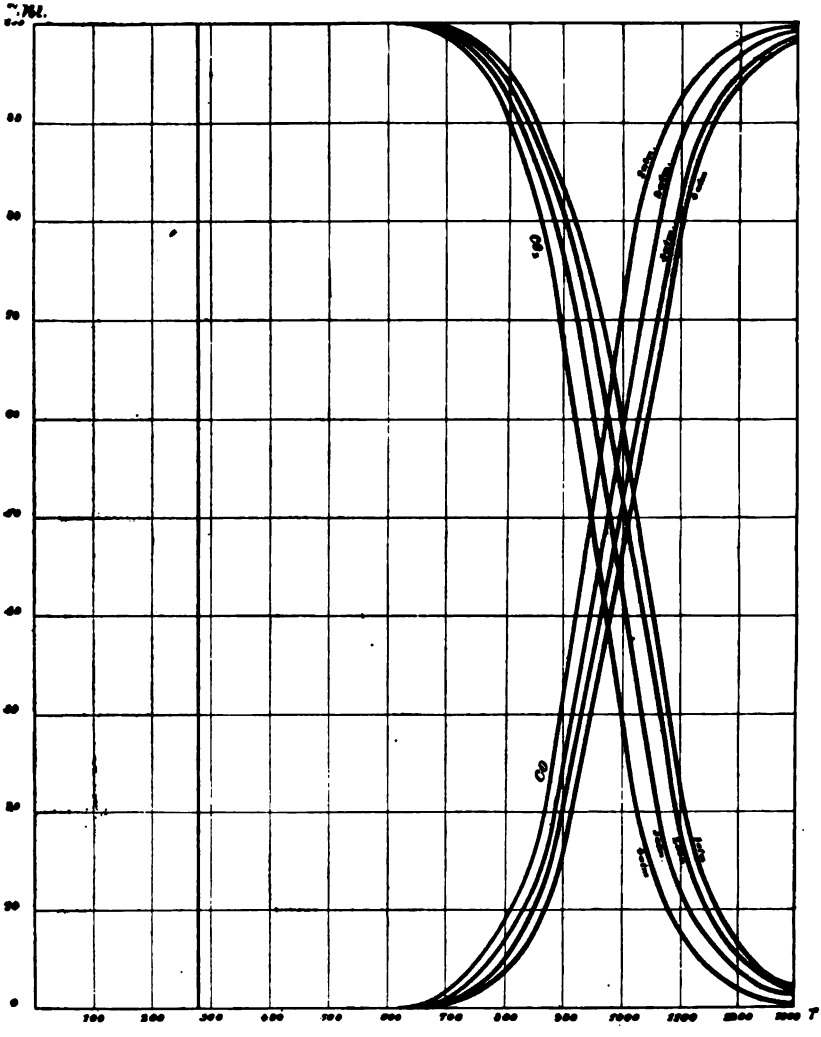
Curves showing Ideal Composition of Producer Gas generated with pure Oxygen and Blast Pressures of 1, 2, 3 and 4 Atms.



H. v. Jüptner. Fig. 82.

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Temperature of Gasification		Partial Pressure of CO + CO_2 in atm.	Composition in % by Vol.		
t° C	T°abs.		CO_2	CO	N_2
		Blast Pressure = 3 atm.			
227°	500°	0.63	21.00		79.00
327°	600°	0.63	21.00		79.00
427°	700°	0.6395	20.51	0.81	78.68
527°	800°	0.686	18.14	4.76	77.10
627°	900°	0.8075	11.94	14.98	73.08
727°	1000°	0.957	4.31	27.59	68.10
827°	1100°	1.025	0.83	33.37	65.80
927°	1200°	1.0365	0.21	34.34	65.45
1027°	1300°	1.04	0.10	34.56	65.34
		Blast Pressure = 4 atm.			
227°	500°	0.84	21.00		79.00
327°	600°	0.84	21.00		79.00
427°	700°	0.851	20.59	0.71	78.70
527°	800°	0.905	18.52	4.11	77.37
627°	900°	1.056	12.73	13.67	73.60
727°	1000°	1.258	5.00	26.46	68.55
827°	1100°	1.359	1.13	32.85	66.02
927°	1200°	1.381	0.28	34.25	65.47
1027°	1300°	1.385	0.13	34.50	65.37

"The data contained in the above table is still plainer in the graphical representation in Fig. 83.

"As in all probability in the future a gas containing 50% of oxygen and 50% nitrogen will have to be considered in the operation of producers, we will give the ideal composition of the gas for such a case.

Temperature of Gasification		Partial Pressure of CO + CO_2 in atm.	Composition in % by Vol.		
t°C	T°abs.		CO_2	CO	N_2
		Blast Pressure = 1 atm.			
227°	500°	0.50	50.00		50.00
327°	600°	0.50	50.00		50.00
427°	700°	0.502	49.40	0.80	49.80
527°	800°	0.522	43.40	8.80	47.80
627°	900°	0.568	29.60	27.20	43.20
727°	1000°	0.633	10.10	53.20	36.70
827°	1100°	0.66	2.00	64.00	34.00
927°	1200°	0.663	1.10	65.20	33.70
1027°	1300°	0.6655	0.35	66.20	33.45

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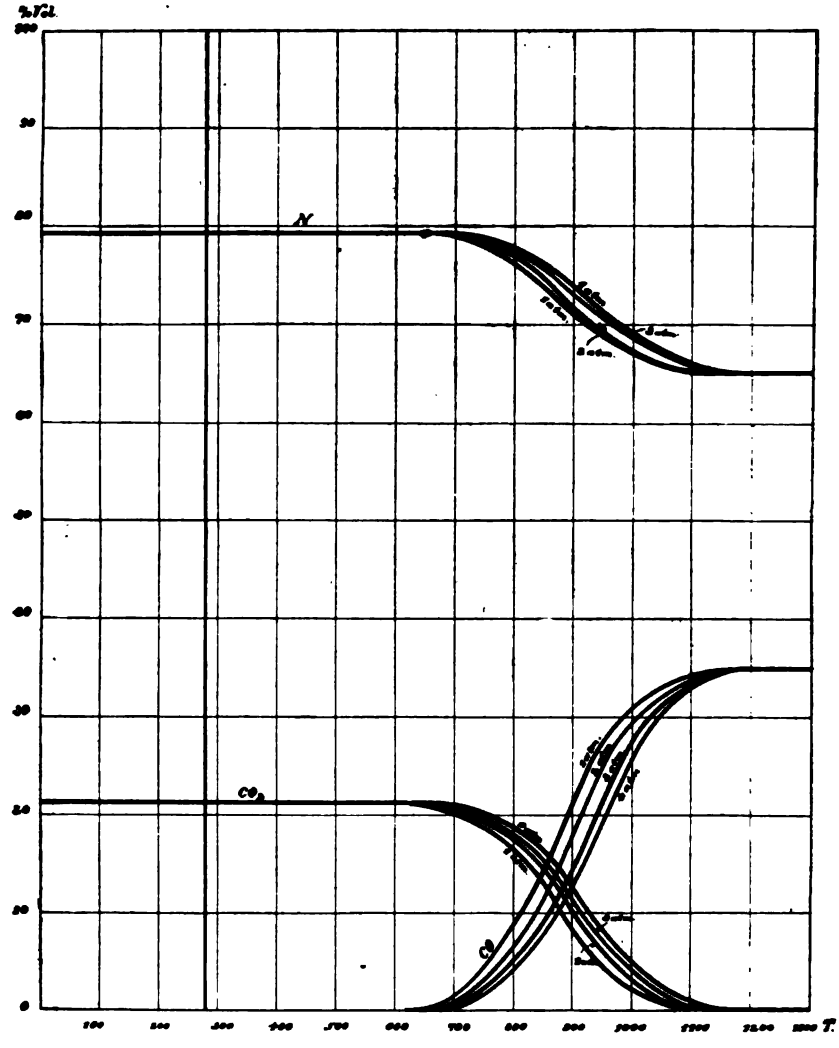
Curves showing Ideal Composition of Producer Gas generated with Dry Air and Blast Pressures of 1, 2, 3 and 4 Atms.



H. v. Juptner; Fig. 83.

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Blast Pressure = 2 atm.

227°	500°	1.	50.00		50.00
327°	600°	1.	50.00		50.00
427°	700°	1.0035	49.56	0.61	49.83
527°	800°	1.0295	45.65	5.83	48.52
627°	900°	1.1065	34.03	21.30	44.67
727°	1000°	1.23	15.50	46.00	38.50
827°	1100°	1.308	3.80	61.60	34.60
927°	1200°	1.326	1.10	65.20	33.70
1027°	1300°	1.3305	0.43	66.10	33.47

Blast Pressure = 3 atm.

227°	500°	1.5	50.00		50.00
327°	600°	1.5	50.00		50.00
427°	700°	1.5045	49.55	0.60	49.85
527°	800°	1.538	46.20	5.07	48.73
627°	900°	1.6345	36.55	17.93	45.52
727°	1000°	1.814	18.60	41.87	39.53
827°	1100°	1.9455	5.45	59.40	35.15
927°	1200°	1.986	1.40	64.80	33.80
1027°	1300°	1.9955	0.45	66.07	33.48

Blast Pressure = 4 atm.

227°	500°	2.	50.00		50.00
327°	600°	2.	50.00		50.00
427°	700°	2.0053	49.60	0.54	49.86
527°	800°	2.0443	46.68	4.43	48.89
627°	900°	2.1615	37.89	16.15	45.96
727°	1000°	2.384	21.20	38.40	40.40
827°	1100°	2.588	5.90	58.80	35.30
927°	1200°	2.6435	1.74	64.35	33.91
1027°	1300°	2.6605	0.46	66.05	33.49

"Fig. 84 gives the corresponding diagram for these tables. From this we can draw the following conclusions:

"1. In every case the amount of carbon dioxide contained in the ideal producer gas at low temperatures has a maximum that remains practically constant at about 400° C.

"2. With rising temperatures the amount of carbon dioxide decreases and becomes, depending on the circumstances, nearly zero between 800° C. and 1000° C.

"3. The amount of carbon monoxide is nearly zero up to about 400° C.

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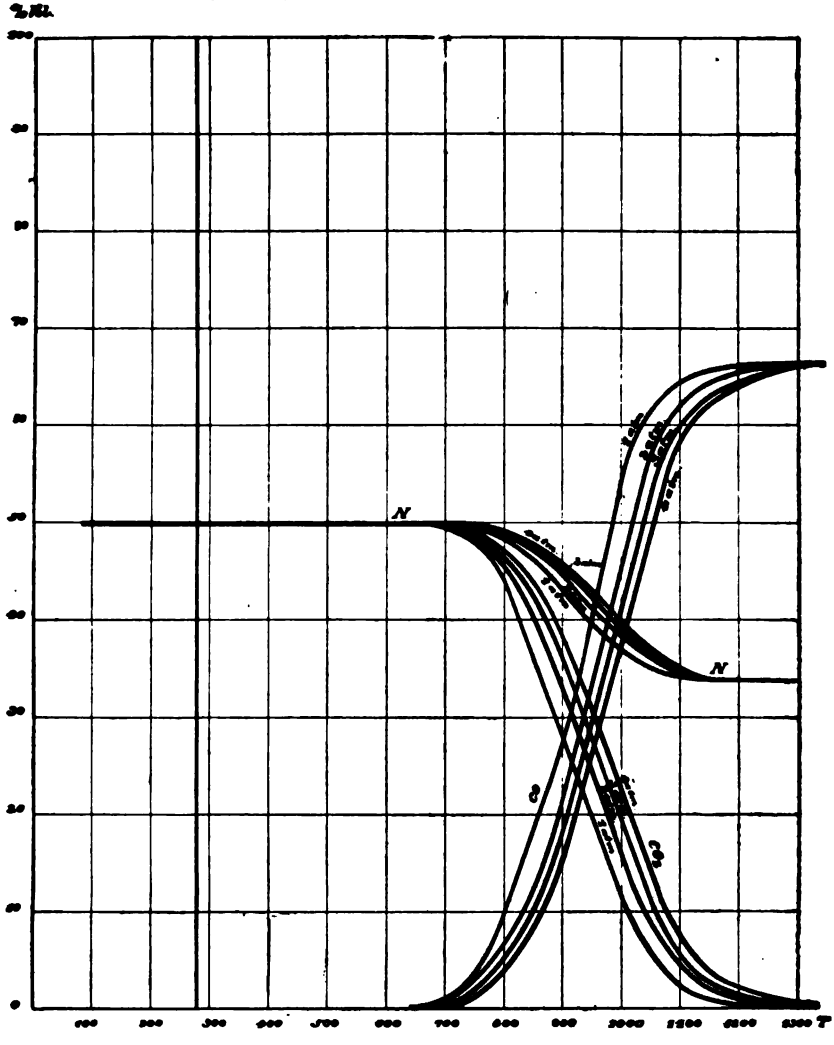
Curves showing Ideal Composition of Producer Gas generated with 50% O and 50% N



N. f. Jüptner; Fig. 84.

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"4. With rising temperatures the amount of carbon monoxide increases and reaches a maximum, depending on circumstances, between 800° and 1000° C.

"5. The amount of carbon dioxide increases at a steady temperature according to the pressure and therefore also according to the amount of oxygen contained in the primary air.

"6. The amount of carbon monoxide produced is in the opposite manner from (5).

"7. At low temperatures the absolute amount of carbon dioxide increases with the amount of oxygen contained in the primary air, and,

"8. At high temperatures the absolute amount of carbon monoxide contained in the gas increases with the amount of oxygen contained in the primary air.

"Therefore, to obtain a producer gas of as high a heat value as possible—that is, containing a large amount of carbon monoxide (with the increase of the amount of CO the amount of N_2 decreases at the same time, so that the heat value of the gas is increased from both sources), it is requisite that :—

"1. The temperature of gasification must be high when the amount of oxygen in the primary air remains constant. However, in practical operation, a temperature of 700° to 900° C. is sufficient, because at these temperatures the maximum amount of carbon monoxide has been nearly attained.

"2. With high temperatures of gasification the quality of the generator gas increases (its amount of carbon monoxide increases) with the amount of oxygen contained in the primary air.

"3. High blast pressures are unfavorable because the amount of carbon dioxide is increased (assuming all other conditions the same).

"If, however, one desires to generate in the producer as large an amount of carbon dioxide as possible, as might be the case during the 'blow' of the water gas process to obtain a very quick rise in temperature, this is only possible (assuming that the equilibrium is to be reached)

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with very low temperatures, because with rising temperatures the amount of carbon monoxide increases rapidly, and the amount of carbon dioxide decreases.

"Should the condition of equilibrium actually be attained in the producer it will not be possible to obtain a high generator temperature; that is, if the producer is being operated with a view of obtaining as large an amount of carbon dioxide as possible. Neither would an increase in the amount of oxygen in the primary air alter these conditions.

WATER GAS.

"Instead of generating the combustible gases by permitting oxygen contained in the air to come into contact with incandescent carbon, we can utilize the oxygen contained in water.

"If steam is brought into contact with incandescent carbon two different reactions take place, according to the temperature.

"With very high heats the decomposition takes place according to the equation:

$$C + H_2O = CO + H_2$$

while as the temperature falls there comes into play, to a greater and greater extent, a second reaction expressed by the equation:

$$C + 2H_2O = CO_2 + 2H_2 .$$

"The first equation furnishes a mixture of equal volume of carbon monoxide and hydrogen; therefore a gas of the following composition:

Carbon monoxide	50% by Vol.
Hydrogen	50% by Vol.

"The second reaction, when appearing alone, furnishes a gas that has for 1 volume of CO_2, 2 volumes of hydrogen, and whose composition would be:

Carbon dioxide	33.33% by Vol.
Hydrogen	66.67% by Vol.

"The thermal value of the first gas equals per 22.42 liters 68 Cal., while the thermal value of the second gas is only 45.4 Cal.

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"A comparison of the air gas process with the two water gas processes results as follows :—

No.	PROCESS.	Composition in % by Vol.				Thermal value per 1 molecule of gas mixture with constant	
		H_2	CO	CO_2	N_2	Vol. Cal.	Press. Cal.
1	$C+\frac{1}{2}(O_2)+2N_2=CO+2N_2$	—	33⅓	—	66⅔	22.6	22.9
2	$C+2H_2O=CO_2+2H_2$	66⅔	—	33⅓	—	45.4	46.5
3	$C+H_2O=CO+H_2$	50	50	—	—	68.0	68.5

"The thermal values refer to equal gas volumes and are therefore especially well adapted for the comparison of quantities of gas. If it is desired, however, to take into consideration the efficiency of the combustibles, it is necessary to refer the thermal value to equal amounts of carbon (equal volumes of CO and CO_2) and we would then have the following :

No.	12 Grammes Carbon equals Liters of Gas.	Thermal value of the gas with constant	
		Volume.	Pressure.
1	67.26	67.8 Cal.	68.7 Cal.
2	67.26	136.2 Cal.	139.5 Cal.
3	44.84	136.0 Cal.	137.0 Cal.

"As will be observed, water gas even in the worst case results in a far greater thermal value than the ideal air gas, to which is to be added that it contains a far smaller proportion of incombustible gases.

"If we desire to carry the comparison completely through, it will be at least necessary to determine the theoretical amount of air required for combustion (although it is not necessary to determine the pyrometric effect—that is, the theoretically attained combustion temperature).

"For each 22.42 liters gas we require :—

	Composition of the gas in % by Vol.				Theoretical amount of air.		GASES.		Products of Combustion.		
	H_2	CO	CO_2	N_2	O_2	N_2	Combustible	Inert.	H_2O	CO_2	N_2
1	—	33⅓	—	66⅔	16⅔	64⅔	33⅓	131⅓	—	33⅓	66⅔
2	66⅔	—	33⅓	—	33⅓	133⅓	66⅔	166⅔	66⅔	33⅓	133⅓
3	50	50	—	—	50	200	100	200	50	50	200

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"As the decomposition of water requires more heat than is generated by the formation of carbon monoxide, or even carbon dioxide, both water gas processes can only be carried to completion by securing heat from an outside source. For we have :

$C + \frac{1}{2}(O_2) = CO + 21100$ Cal.

$C + 2H_2O = CO_2 + 2H_2 + 97600 - 138000 = CO_2 + 2H_2 - 40.4$ Cal.

$C + H_2O = CO + H_2 + 26100 - 69000 = CO + H_2 - 42.9$ Cal.

If we take this supply of heat into consideration we have:

PROCESS.	Thermal Value of the gas per 12 grm. Carbon.	Amt. of heat to be supplied from outside sources.	Gain in heat.
$C + \frac{1}{2}(O_2) + 2N_2 = CO + 2N_2$	68.7 Cal.	— 21.1 Cal.	89.8 Cal.
$C + 2H_2O = CO_2 + 2H_2$	139.5 Cal.	+ 40.4 Cal.	99.1 Cal.
$C + H_2O = CO + H_2$	137.0 Cal.	+ 42.9 Cal.	94.1 Cal.

"The absolute gain in heat in water gases is not a large one, and becomes smaller when we consider the heat losses due to supplying the necessary amount of heat in the producer. The superiority of water gas does not, under any circumstances, consist in a gain of heat, but in the fact that a gas of greater thermal value is obtained, and because it is possible to utilize the heat of combustion to better advantage.

"As can be seen from the above considerations, the first process which takes place when steam is brought into contact with a layer of incandescent carbon is, according to the equation, $C + H_2O = CO + H_2$. But as heat is absorbed by this process (endothermic reaction) the layer of carbon will cool and there will appear simultaneously with the first process a second one, $C + 2H_2O = CO_2 + 2H_2$.

"As the cooling proceeds, the second reaction becomes more pronounced, until finally the carbon in the generator becomes so cold that the process comes to a standstill,

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and the steam introduced into the layer of carbon passes through undecomposed. This makes it necessary to reheat the carbon contents of the generator, which is accomplished by shutting off the steam and permitting air to be blown through it (generating air gas, that may be collected and utilized independently) until the fire is again sufficiently heated. This is called the 'blow.' After this has been accomplished, the blast is cut off and steam turned on again (run) until the temperature has dropped so low that the water gas process does not take place economically.

"Therefore we are obliged to deal with an intermittent process, which not only requires careful attention but which also necessitates the erection of at least double the number of generators, where continuous production is requisite, and a gas holder is undesirable.

"As we have seen, both water gas processes take place simultaneously, but as one results in a far better gas, and better fuel efficiency, it is important to know the conditions under which decomposition proceeds in both processes. For this purpose we will study the conditions of equilibrium between both reactions.

"To establish the equilibrium in the gaseous condition, it is first necessary to find a reaction between the constituents of each. We find such simply by substracting the reactions,

$$C + H_2O = CO + H_2$$

and,

$$C + 2H_2O = CO_2 + 2H_2$$

from each other. In this manner we secure the following reaction:

$$CO_2 + H_2 \rightleftharpoons CO + H_2O$$

"This is a reversible reaction, in which we secure two volumes ($CO_2 + H_2$) from two volumes ($CO + H_2O$) which are independent of their pressure at such temperatures where water appears as steam (and these are the only ones we can here consider). We could surmise that

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the composition of water gas under given temperatures would be independent of the pressure. This, however, is not the case, as the following observation will show:

From the last reaction the isothermic equilibrium:

$$K_1 = \frac{C_{CO}\, C_{H_2O}}{C_{C_xO}\, C_{H_x}}, \text{ follows,}$$

or,

$$\frac{C_{CO}}{C_{CO_2}} = K^1 \frac{C_{H_x}}{C_{H_xO}}$$

"Therefore, at any given temperature, any proportion of CO : CO_2 corresponds to another proportion of H_2 : H_2O. To arrive at definite results we must find a reaction which establishes the equilibrium between the gaseous constituents, which in this case consists of CO_2, CO, H_2 and H_2O, and the solid C, and as such we will choose the equation used in the air gas process,

$$CO_2 + C \rightleftarrows 2CO$$

For this we can substitute,

$$K_2 = \frac{(C_{CO})^2}{C_{CO_2}}$$

and now the conditions for establishing the isothermic equilibrium are given. As this last reaction is dependent on the pressure, it follows that the composition of the water gas is dependent upon the pressure.

"The theory of the water gas process has been thoroughly discussed previously (Jüptner Phys. Chemistry), and it will suffice to give the results of such a theoretical research.

"Expressing the steam pressure with Π and the temperature of gasification (in °C) with t, the ideal composition of the water gas—that is, the composition corresponding to the attained condition of equilibrium—is as follows:—

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% by Volume	STEAM PRESSURE (Π) IN ATMOSPHERES											
	0.1	0.25	0.5	0.75	1.0	1.5	2.0	2.5	3.0	4.0	5.0	10.0
						t = 400° C						
CO	0.24	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00
CO_2	10.88	7.86	5.97	5.04	4.46	3.73	3.27	2.97	2.73	2.40	2.15	1.55
H_2	21.99	15.84	11.99	10.12	8.94	7.48	6.56	5.94	5.47	4.82	4.31	3.11
H_2O	66.88	76.18	81.98	84.80	86.57	88.77	90.15	91.08	91.79	92.77	93.53	95.34
						t = 600° C						
CO	26.66	18.87	14.65	11.56	10.03	8.14	6.99	6.20	5.61	4.78	4.22	2.87
CO_2	12.84	16.06	17.15	17.79	17.86	17.67	17.41	17.12	16.84	16.32	15.88	14.32
H_2	52.34	50.89	48.95	47.14	45.75	43.48	41.81	40.44	39.29	37.42	35.99	31.51
H_2O	8.16	14.18	19.25	23.51	26.36	30.71	33.79	36.24	38.26	41.48	43.91	51.30
						t = 800° C						
CO	49.04	47.81	46.04	44.46	43.06	40.56	38.53	36.83	35.41	32.81	30.69	24.38
CO_2	0.50	1.13	2.02	2.80	3.48	4.66	5.59	6.34	6.95	8.02	8.88	11.05
H_2	50.03	50.07	50.08	50.06	50.02	49.88	49.71	49.51	49.21	48.85	48.45	46.48
H_2O	0.43	0.99	1.86	2.68	3.44	4.90	6.17	7.32	8.43	10.32	11.98	18.09
						t = 1000° C						
CO	50.00	50.00	50.00	50.00	50.00	49.42	49.42	49.00	48.57	48.35	47.98	46.24
CO_2						0.25	0.25	0.45	0.61	0.71	0.87	1.59
H_2	50.00	50 00	50.00	50.00	50.00	49.92	49.92	49.90	49.79	49.77	49.72	49.42
H_2O						0.41	0.41	0.65	1.03	1.17	1.43	2.75
						t = 1200° C						
CO	50.00	50.00	50.00	50.00	50.00	50 00	50.00	50.00	50.00	49.32	49.31	49.31
CO_2										0.25	0.25	0.25
H_2	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	49.82	49.80	49.80
H_2O										0.61	0.64	0.64
						t = 1400° C						
CO	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
CO_2												
H_2	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
H_2O												

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"Figs. 87 and 88 show the ideal composition of water gas at a steam pressure of 1 atm. and 4 atm. in diagrammatic form. In general the tendency of the curves, under increasing pressure, is towards higher temperatures. Furthermore, these diagrams show that the amount of undecomposed steam decreases very rapidly commencing at a certain temperature, while the amount of carbon monoxide and hydrogen increases rapidly.

"In the middle portion of the last two curves, they are nearly parallel, but the hydrogen curve commences to rise at about 200°C prior to the carbon monoxide curve. Simultaneously with the hydrogen curve the carbon dioxide curve commences to rise (although slowly) until it intersects the steam curve, and then drops practically simultaneously with it.

"From this we find, for practical operation, that the most favorable gasification temperature lies somewhere within a temperature interval of about 200°, and increases with the steam pressure."

The foregoing extract from Jüptner's treatise may appear somewhat out of place, but I do not consider it in that sense, because it may become applicable in separate producer installations.

In addition to these extracts from Jüptner's admirable book I will refer any one desirous of delving into these questions to a paper entitled, "Steam in Gas Producer Practice; An Investigation on the Use of Steam in Gas Producer Practice," by W. A. Bone, D. Sc., Ph. D., F. R. S., Professor of Applied Chemistry (Full and Metallurgy), Leeds University; and R. V. Wheeler, M. Sc., late Dalton Scholar and Research Fellow of Manchester University; Chemist to Messrs. Monk, Hall & Co., Ltd., Warrington, England. This paper is published in the American Gas Light Journal of June 3, 1907, and continued in the issue of June 10, 1907.

I will also quote from a letter I received from Dr. J. Bueb, of Dessau, Germany, under date of July 27, 1907, as follows:—

"In regard to the reactions which take place in producers—whether carbon and oxygen burn directly to carbon dioxide, whether the carbon dioxide is subsequently

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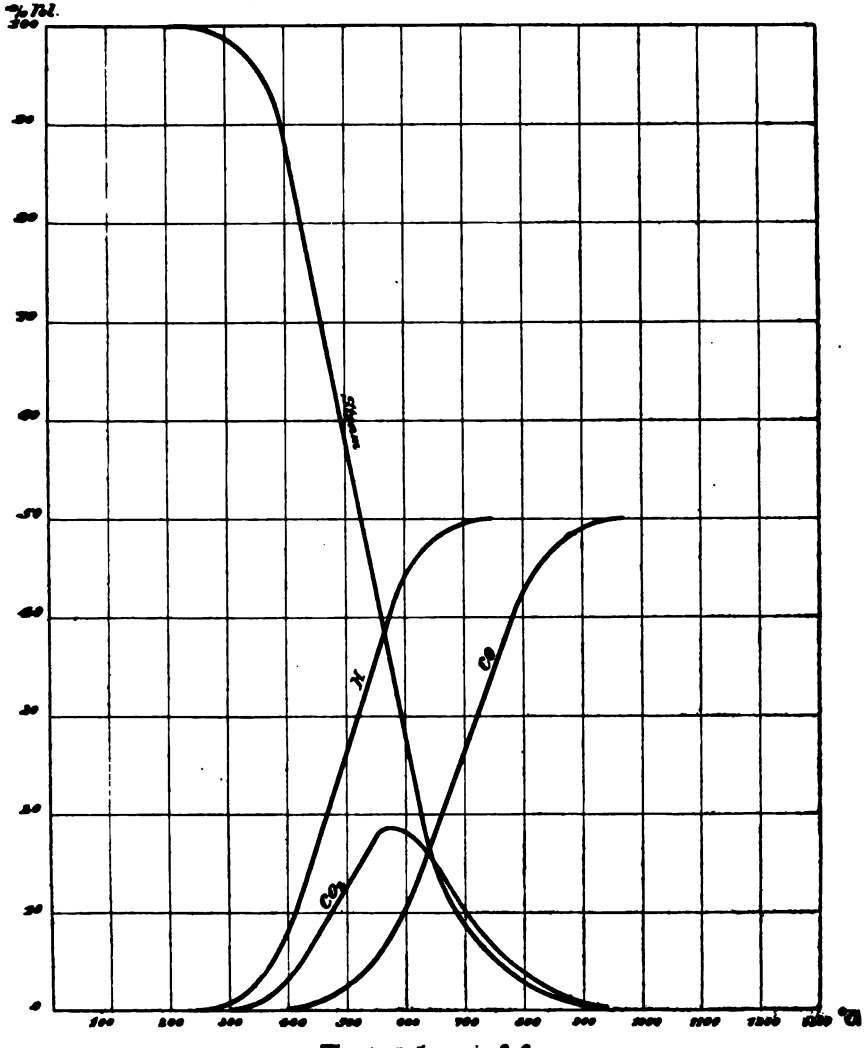
IDEAL COMPOSITION IN PER CENT BY VOLUME OF WATER GAS WITH BLAST PRESSURE OF 1 ATM.



H. v. JÜPTNER; Fig.ª 87.

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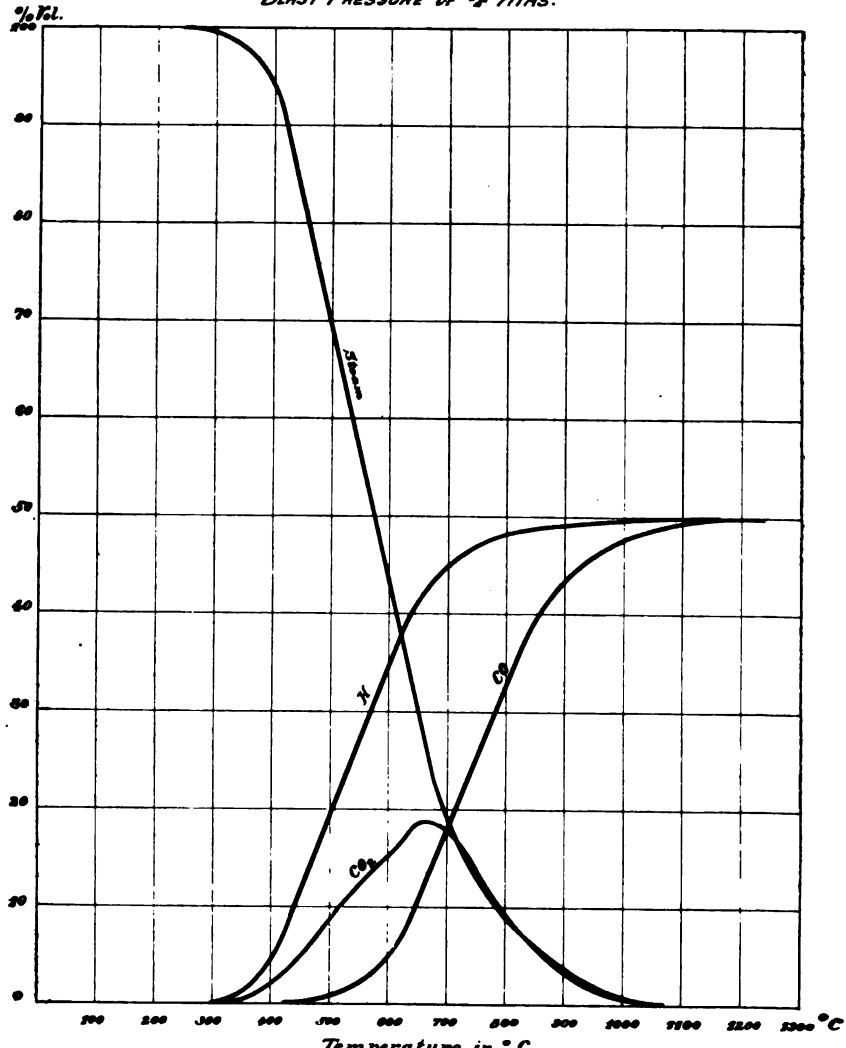
Ideal Composition in Per Cent by Volume of Water Gas with Blast Pressure of 4 Atms.



H. v. Juptner; Fig. 88.

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dissociated, or whether slow combustion takes place first to CO and then to CO_2—these are matters about which scientists are not yet agreed. These reactions probably all take place simultaneously, and whatever reaction predominates is probably largely dependent upon the temperature."

In connection with the use of water or water vapor under gas producers, I wish to insert a table kindly furnished me by Mr. A. H. Strecker, of Newark, New Jersey. This table was compiled by Dr. H. Bunte, of Karlsruhe, Germany, and shows the effect of water vapor upon secondary combustion and temperature of same. The calculation is made from the known flame temperature of the gases under consideration. Dr. Bunte's figures mean simply the elevation of temperatures by the combustion of these gases, above those of the fuel and air supplied to the furnace. In practice these temperatures will be much less, owing to radiation, cooling influence of charges, excess of air supplied, and other causes. The figures are based upon the exact theoretical amount of air required.

Dr. Bunte assumes the air for primary combustion to have a temperature of 500° Cent., or 932° Fahr., and that for secondary combustion a temperature of 1000° Cent., or 1832° Fahr. His results are figured on the basis of a "Munich" furnace, where the steam needed is entirely produced by evaporation of water by the flue gases. The ash pan is covered so that the fire loses none of its heat by radiation into the water contained therein.

Dr. Bunte's tabulated results are as follows:

How Operating.	Initial Temp. in Gen.	Initial Temp. in Combustion Chamber, with Secondary Air.		Distribution of Primary and Secondary Air by Volume.	
				Primary.	Secondary
1. Without steam	2640° F.	4937° F	5770° F.	1	1
2. With steam, 1 C to 0.42 H_2O—primary air cold	1284° F.	4617° F.	5604° F.	0.72	1.28
3. Do. primary air at 932° F	1870° F.	4897° F.	5884° F.		
4. With steam, 1 C to 0.567 H_2O—primary air 932° F.	1267° F.	4751° F.	5801° F.	0.62	1.38

See "Journal für Gasbeleuchtung" No. 15 of 1904.

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RETURN FLUE GAS VS. STEAM AS METHODS FOR CLINKER PREVENTION AND FUEL ECONOMY.

Probably no more fascinating study in connection with producer work can be found than that relating to fuel economy. Closely related to this we find the subject of clinker prevention naturally affiliated with fuel economy. Any discovery or invention tending towards greater economy in fuel consumption, or which absolutely and cheaply disposes of clinker formation, is surely to be reckoned among the good things that come to mankind.

The formation of clinkers is dependent upon temperature. The silicon, calcium and iron constituents of any given fuel are largely responsible for the clinker formation, and it results from the fusing or fluxing of the slag. Heretofore water or steam has been used to keep down the temperature of the fire, and it has fulfilled its purpose with varying degrees of satisfaction. Of late years, however, certain other methods for clinker prevention have made their appearance, among the most prominent of these being the return of a portion of the waste products of combustion under the fire.

This returning of a portion of the waste products of combustion under the fire is a subject of considerable importance just now. I am frank to say that I do not believe a strictly up-to-date discussion of retort house practice can be written at this time leaving this matter out of consideration. I will, therefore, give such results of the use of this method as I have been able to secure both abroad and in this country, and will give such a portion of its history as may be of interest in this connection.

At this time I wish to say most emphatically that my statements are to be received strictly in the sense that my discussion is to be upon the merits of the case, and is not to be considered or interpreted in any way as reflecting upon the validity or non-validity of any of the patents involved. What we wish to know is what merit there is to the method, the facts, if they can be secured, and that is all.

In the first place we will look into some of the history of these ideas. I am naturally unable to go into this matter very

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deeply, for lack of time, and because I do not believe we could gain very much exact knowledge from the experience with this or similar methods, in the early stages of their exploitation. Referring first to the 1901 edition of "Die Gaserzeuger und Gasfeuerungen," by Ernst Schmatolla, we find on page 80 the beginning of a chapter on the Siemens' Regenerative Furnace. This chapter describes the standard regenerative construction as invented by Friedrich Siemens in 1856.

Following this chapter there is one headed, "The New Siemens Furnace with Chemical Regeneration." This latter chapter begins on page 87, and in the second paragraph we find a statement that a certain furnace is illustrated in this chapter after the latest patent of the "Aktiengesellschaft für Glasindustrie, formerly Friedrich Siemens" in Dresden, as per patent No. 114531.

Quoting the paragraph following we have:

> "In addition to the location of the generators in contact, or next to, the furnace, a considerable saving in fuel is said to be effected in this style of construction by the introduction of a portion of the hot waste gases, which is again passed through the gas generator. Since the products of combustion consist mostly of carbon dioxide, water vapor, and nitrogen, the carbon dioxide and water vapor are reduced as per the following formulæ:
>
> $$CO_2 + C = 2\,CO.$$
> $$H_2O + C = H_2 + CO.$$"

Thereupon there follows a specific description of this particular type of Siemens regenerative furnace (I am using the term "regenerative" advisedly) with drawings. The portion of the hot waste gases to be returned to the producer is shown and described as being taken off before these waste gases enter the regenerator, and is forced under the grates by means of jets or injectors (kind not stated). Separate jets or injectors are provided for introducing other primary air. The first-named jets are stated to be so arranged that the introduction of the waste products under the fire, or of hot air from the regenerators, can be brought about. No results are stated, and all one can learn from this chapter is the fact that Siemens

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used this method, and it is stated that a considerable saving in fuel resulted.

Going back somewhat earlier in the history of these methods, we find there was a patent issued to Friedrich Siemens of Dresden, Germany, on June 17, 1891, D.R.P. 69651 (D.R.P. means Imperial German Patent).

The following "patent claims" are translated from this patent:—

> "1. A gas generating furnace in which the products of distillation from the upper layers of the firing material are conducted from the charging spout 'T' to a special chamber 'B,' where they are burned with air brought into this chamber; whereupon the hot mixture of gases and vapors is forced to and under the gas producer itself by means of a steam jet.
>
> "2. A gas generating furnace of the above mentioned construction, in which, for the purpose of saving fuel, a stream of gas containing hot carbon dioxide (for example hot products of combustion) is conducted to the chamber 'B' in place of air."

Thereupon there follows a description of the process. In the first place it is distinctly set forth that only a portion of the total gas generated is conducted to the chamber "B," to be burned, and then forced under the producer by means of a steam jet. Siemens claims that gases that can be condensed, such as water vapors, tar or lamp black, which are so detrimental in ordinary producer gas, exist only in very small quantities in this method. It is also distinctly stated that the highly heated carbon dioxide, steam and nitrogen resulting from the combustion in the chamber "B" is used for the generation of gas in the fuel bed instead of cold air. It is again stated that the hereby occasioned saving must be looked upon as a considerable one, especially where a fuel of low value is used, but it is said the process is not so advantageous where good coal is used. A separate steam jet is provided to force air under the fuel bed when required. Coke or coal can be used.

The gist of the last named patent of Siemens seems to be that producer gas is to be burnt and forced under the generator by a steam jet, and that also a stream of gas containing

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carbon dioxide can also be led to the producer, but the means of so doing appears to be distinctly stated as a steam jet.

In the "Handbuch der Chemischen Technologie," by Dr. Ferdinand Fischer, 1900 edition, Book I, on page 41, we find a statement that Fr. Siemens proposes to use the carbon dioxide of the products of combustion to gasify carbon by means of the equation

$$C + CO_2 = 2\,CO.$$

It is here stated that about one-half of the products of combustion are blown into the gas producer. Such a construction is said to be installed in the Pather Iron and Steel Company Works in Frishaw. In the description it is further stated that the waste gases are forced under the furnace by means of jets or injectors. It is further said that the statement that large savings in fuel are made is very doubtful. It is also stated that the entire process is such that the question of its advantage over other methods is still to be proved.

In the book by the same author for the year 1893, entitled "Jahres-Bericht über die Leistungen der Chemischen Technologie," on pages 111, 112, 113, 114, we find several calculations and statements concerning the value or non-value of the method of returning the waste products of combustion which contain carbon dioxide. The gist of the calculation results in the statement that it is better to use water vapor well mixed with air than to use waste gases.

I will give a translation of the calculations in Fischer's Jahres-Bericht for 1893, but before doing so wish to quote from a letter I received from Dr. J. Bueb, from Dessau, Germany, under date of July 27, 1907:

> "The introduction of waste gases under a fire, as applied in the glass industry by F. Siemens, has not proved satisfactory where applied in gas works to date, on account of the complication of the proceeding."

Dr. Bueb then refers me to F. Siemens Company, in Dresden.

Returning now to the calculation in Dr. Fischer's book, 1893, we have the following extracts, beginning on page 107 and ending on page 114. Remember that the metric system

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of weights and measures is used throughout the German calculations.

Extracts from Calculations from Dr. Ferdinand Fischer's Jahres-Bericht for 1893 :—

" In order to gasify carbon the following well-known reactions take place :—

	Reaction No.	Heat Developed. Calories.	Thermal Values of the Resulting Gases. Calories.
1.	$C + O_2 = CO_2$	97000	0
2.	$C + O = CO$	29000	68000
3.	$C + CO_2 = 2\ CO$	—39000	136000
4.	$C + H_2O = CO + H_2$	—39400	136400
	(Water vapor from 20°)	—28600	125600
5.	$C + 2\ H_2O = CO_2 + 2H_2$	—39800	136800
	(Water vapor from 20°)	—28200	125200

This means that, taking equation No. 2, 12 kg. C., and 11.15 cbm. O (with 41.95 cbm. N), or 53.1 cbm. resulted in 22.3 cbm. CO, and 64.2 cbm. of mixed gas of the following composition :—

CO 34.7%
N 65.3%

" This equation, with the foregoing quantities of material, produces or sets free 29000 heat units, which gives the gases a temperature of approximately 1500° (not considering the losses in the generator).

" The application of carbon dioxide from the preceding equations appears to result about the same as that of liquid water, as per equations 3 and 5.

" It is to be noted that the temperature in a producer must be practically 1000° C. to allow the reactions shown in equations 3, 4 and 5 to take place. In order to keep the temperature in the generator up to about 1000° it is necessary to expend about 19000 heat units. There is thus available about 10000 heat units left over for use otherwise from reaction No. 2.

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"Since the application of equations 3 and 5 result about the same in heat developed and thermal capacity, we can only use one CO_2 (Eq. No. 3) for every four reactions No. 2 as follows:

4 No. 2 = $4C + 4O = 4CO$.

1 No. 3 = $C + CO_2 = 2\ CO$, or combined these result in

$5C + 2\ O_2 + CO_2 = 6\ CO$.

"The resulting gas has the following composition:

Carbon Monoxide	133.8 cbm.	44.3%
Nitrogen	167.8 cbm.	55.7%
	301.6 cbm.	

"60 kilogram carbon therefore result in 301.6 cbm. gas of 408000 heat units thermal value, about 84% efficiency; the use of carbon dioxide for gas production therefore can not be of much value.

"Siemens uses waste products of combustion containing carbon dioxide, and therefore introduces about 90 cbm. nitrogen with 22.3 cbm. carbon dioxide (see J. 1890–190). The resulting gas would then have the following composition:

Carbon monoxide	133.8 cbm.	34.2%
Nitrogen	257.8 cbm.	65.8%
	391.6 cbm.	

"In fact this composition of the gas could not be attained without greatly preheating the same, because it requires about 27000 heat units to raise the temperature of the 90 cbm. nitrogen to the producer temperature, 1000°, so that more than one-half of the available heat would be used for this purpose.

"54 kg. carbon could therefore produce,

Carbon monoxide	111.5 cbm.	34.4%
Nitrogen	212.8 cbm.	65.6%
	324.3 cbm.	

which have a thermal value of 340000 heat units, or 78% efficiency. Therefore, considering the efficiency of

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the process from a standpoint of the total heat development of the fuel, the use of water vapor is much more desirable than that of products of combustion containing carbon dioxide. Calling the gas under the latter (Siemens) discussion 3a, we have the following tabular comparison of the various equations:

Equation Number		2	3a	4	5
1 kg. C. produces gas in cbm.		5.35	6.01	4.94	5.41
Composition of Resulting gas in %	CO_2	—	—	—	8.6
	CO	34.7	34.4	37.6	25.8
	H	—	—	9.4	17.2
	N	65.3	65.6	53.0	48.4
No. cbm. air required to burn 1 cbm. gas		0.83	0.82	1.12	1.02
Products of combustion in cbm. of 1 cbm. of gas	CO_2	0.35	0.34	0.38	0.34
	H_2O	—	—	0.09	0.17
	N	1.31	1.31	1.41	1.29
	Total	1.66	1.65	1.88	1.80
Thermal value of 1 cbm. gas (Water vapor from 20°)		1058.	1049.	1389.	1231.
Available heat units of the next above thermal value, if the products of combustion escape at 1000°		477.	471.	731.	601.
Do. for 1 kg. carbon		2552.	2831.	3611.	3251.

"From the above table it appears that the use of products of combustion as per 3a is not as efficient as the application of water vapor. An inspection of equation No. 4 shows this to be the one we should strive to produce.

"If, on the other hand, we could arrange to preheat the mixture of primary air up to, say, 500° to 550°, we could utilize the equations as follows, on account of having more available heat.

3 No. 2 = 3 C + 3O = 3 CO.

2 No. 4 = 2 C + 2H_2O = 2 CO + 2H_2, or combined,

5 C + 3O + 2H_2O = 5 CO + 2H_2.

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"Again,

3 No. 2=3 C + 3O = 3 CO.

2 No. 5=2 C + 4 H_2O = 2 CO_2 + 4 H_2, or combined,

5 C + 3O + 4H_2O = 2 CO_2 + 3 CO + 4 H_2.

"From this we see that 60 kilogram of carbon combine with 159 cbm. air and 36 and 72 kg. water vapor respectively (equations 4 and 5), and result in :

	Eq. 4	Eq. 5
CO_2	—	44.6 cbm.
CO	111.5 cbm.	66.9 cbm.
H	44.6 cbm.	89.2 cbm.
N	125.8 cbm.	125.8 cbm.
Total	281.9 cbm.	326.5 cbm.
Total thermal value (water vapor from 20°)	455200 Cal.	434400 Cal.
Efficiency	94%	90%
1 kg. C. results in gas	4.7 cbm.	5.44 cbm.
Composition of gases in % — CO_2	—	13.7
Composition of gases in % — CO	39.5	20.5
Composition of gases in % — H	15.8	27.3
Composition of gases in % — N	44.7	38.5
Thermal value of 1 cub. meter gas	1612 Cal.	1330 Cal.

"This tabulation shows that the preheating of the mixture of water vapor and air has a very favorable influence. In gas benches where high heats are required, this preheating would probably be made to go as high as 1000°. The entire heat of reaction 2 could then be changed into chemical work, and for one reaction No. 2 we could add one reaction No. 4 (No. 5 is out of the question at this temperature), and for 4 No. 2 almost 3 No. 3 could be applied. To obtain pure carbon dioxide is apparently out of the question, so that only products of combustion (with 20% of CO_2) can be considered.

4 No. 2=4 C + 4O = 4 CO.

3 No. 3=3 C + 3 CO_2 = 6 CO, or combined,

7 C + 4O + 3 CO_2 = 10 CO.

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"Again,

1 No. 2=C + O = CO.

1 No. 4=C + H_2O = CO + H_2, or combined,

2 C + O + H_2O = 2 CO + H_2.

"The results are as tabulated.

Equation No.		3a	4
Amounts of resulting gas	CO_2	—	—
	CO	223.0 cbm.	44.6 cbm.
	H.....	—	22.3 cbm.
	N.....	435.4 cbm.	42.0 cbm.
Total.....		658.4 cbm.	108.9 cbm.
1 kg. C. produces gas.....		7.82 cbm.	4.54 cbm.
Composition of gases in %	CO_2	—	—
	CO	33.9	40.9
	H	—	20.5
	N.....	66.1	38.6
Thermal value of 1 cub. meter gas.....		1034 Cal.	1776 Cal.

"If the gas and air for combustion are brought into the furnace at the same temperature as that at which the products of combustion leave the furnace, it is evident the entire heat of the gasified coal is used up in the furnace, excluding the losses through the walls. Practically this is not possible, and the gases must always leave the producer much hotter than they can enter it in this particular method. If gas and air enter at 1000° and the products of combustion leave at 1400° we have the following:—

Equation No.		3a	4
1 cbm. gas results in cbm. of products of combustion	CO_2	0.34	0.41
	H_2O.....	—	0.20
	N.....	1.30	1.54
		1.64	2.15
Thermal value of 1 cbm. of gas...		1034 Cal.	1776 Cal.
Of this there is available.....		772 Cal.	1432 Cal.

"In order to introduce equal quantities of heat into the furnace, it is necessary to use twice as much gas

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produced from carbon dioxide (3a) as that from water vapor. Therefore it would be necessary to use apparatus about twice as large, which would result in correspondingly greater heat losses, by radiation, so that the introduction of gas produced by products of combustion is still more undesirable than shown above.

"In the new Siemens furnace, a portion of the products of combustion is conducted under the grates by means of a steam jet. It has already been proved that the claims under this invention were not correct (see J. 1890–191.), and the foregoing figures show that the introduction of products of combustion, even at a temperature as high as 1000°, is very uneconomical.

"The only question remaining, therefore, is whether it is economical to introduce still hotter gases. The reaction $C + CO_2 = 2\ CO$, requires 39000 heat units; 22.3 cbm. carbon dioxide are mixed with approximately 90 cbm. nitrogen, or there are approximately 112 cubic meters of products of combustion.

"If we assume the specific heat of these gases over 1000°, even as high as 0.4, the gases would have to be conducted to the generator some 900° hotter than is requisite for the reaction, or at a temperature of about 1900°, which cannot be accomplished readily in practice. Siemens introduces steam at the same time, which again necessitates considerable quantities of heat for raising its temperature and decomposing it. Without introducing air at the same time this proposition is impossible. The reaction :

$$2\ C + CO_2 + H_2O = 3\ CO + H_2$$

requires 68000 heat units. If the products of combustion were introduced into the generator at 1400° they carry with them 17900 heat units, whereas the heating of the vapor up to 1000° requires 8800 heat units. There would then remain 59000 heat units to be supplied by the reaction

$$C + O = CO = 29000 \text{ heat units.}$$

" Under the most favorable circumstances the air could be introduced at a temperature of 1200° about, and the reaction then would be :

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$$4\,C + CO_2 + H_2O + O_2 = 5\,CO + H_2.$$

"Therefore, 46 kg. carbon, 112 cbm. of products of combustion, 18 kg. water vapor, and 106 cbm. air would result in the following gas :—

CO.....	111.5 cbm.	36.3%.
H.....	22.4 cbm.	7.3%.
N.....	173.1 cbm.	56.4%.
	307. cbm.	

Thermal value of 1 cubic meter gas = 1295 Cal.

"It appears, therefore, as though the gas obtained even under such favorable conditions, is not as economical or efficient a process as that obtained by the use of water vapor ; in fact, owing to the inevitable losses, the results will be much poorer.

"The introduction of products of combustion into a gas producer is therefore in every respect an unfavorable proposition, and the circulation of the great quantities of nitrogen always results in large heat losses. If the process really results in a saving of 50% of fuel, as claimed, it merely goes to prove that the previous operation under the old method was just that much poorer than it should have been."

According to Dr. Fischer's calculations as above, as extracted from his Jahres-Bericht for 1893, it would appear that there is theoretically every reason to believe that the process of returning waste gases back under the fire is not as economical as to use water vapor. I searched through Jüptner's work in the hope of finding some reference or calculations relating to this subject, but am unable to see anything. In the further hope of securing some facts, or working data on this method as applied abroad, I have written to F. Siemens & Company, of Dresden, Germany, for their actual experience along this line, in the glass, as well as in the gas industry. I also have a promise from Dr. H. Bunte, of Karlsruhe, Germany, to recite his ideas and experiences. If these two answers arrive in time, they will be found among the addenda at the end of the paper, otherwise they will have to be reserved for future use.

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EFFORTS MADE IN THE UNITED STATES TO ACCOMPLISH GREATER FUEL ECONOMY AND FOR CLINKER PREVENTION.

My discussion so far has been entirely on the work done abroad. Upon investigating the inventions and research work undertaken in this country I have been unable to find anything except certain patents and applications of same in certain plants. The patents that have come to my knowledge are 829105, 844504, and 848729. It is not my intention to go into the details of these patents, as any one desirous of studying them can readily obtain copies from the U. S. Patent Office at Washington, D. C.

I have, however, endeavored to secure working results from some of the installations already put in, and to ascertain from these plants the commercial value of the method. I regret very much that St. Louis has no recuperative benches operating on coal gas, or I should certainly have made thorough tests to be presented in this paper. In the next section of this paper you will find the actual reports of operation of a large number of companies, in reply to a circular list of one hundred questions that I sent out. Among these will be found the answers of one Company using the return flue gas method, as patented in this country. I have also the unofficial report of one other Company from one of their chemists no longer in their employ, in the form of a letter, which I will quote later on.

Referring first to the one Company whose answers will be found later on, under No. 34, we find as follows:

This Company operates benches of 6's with average fire-depths of five feet. Now what criticisms can be applied to their answers as far as the return flue gas method is concerned?

First, they have but one station meter, and the coal gas and water gas are mixed before passing through this meter. This at once makes all their reported results very doubtful. I would not be surprised if these results were wrong as much as 5%, or possibly even as much as 8 or 10%, because they certainly estimate the results of one kind of operation, say coal gas, and get the water gas results by subtracting from the total.

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Second, they fail to give the size, kind of drum, and maximum rate per hour of sending gas through the station meter. Without absolute knowledge at hand, I very much suspect their station meter is greatly overloaded at certain hours of the day at least, a condition conducive to great non-accuracy. Furthermore, not giving their ideas as to the accuracy of the station meter during the past twelve months, would lead me to strongly suspect that perhaps the drum was badly rusted out, possibly full of holes, etc. This may not be true, but it throws doubts on the results. Note also that ten of their benches were refilled completely as far back as 1900.

Otherwise the answers are clear and not subject to criticism. The bench fuel reported by No. 34 is 246 pounds coke per ton coal carbonized, obtained largely, we assume, by the use of the return flue gas method. As contrasted to this, observe the answer of Company No. 7, which reports 235 pounds coke as bench fuel per ton coal carbonized. Observe also, the difference in the coal itself, and the thermal value of the coke. Company No. 7 does not use return flue gas scheme, but separately meters its coal gas, and there is no criticism to make on its operation.

I was unable to secure any official data as to the return flue gas installation at St. Paul, but have a letter from Mr. R. M. Redding, who was formerly chemist of the St. Paul Gas Light Company, under date of August 10, 1907, which I herewith reproduce in full.

(Dated)

"New Orleans, Aug. 10th, 1907.

Mr. W. A. Baehr, Engineer,
Laclede Gas Light Co.,
St. Louis, Mo.

Dear Sir:—

Mr. Miller has handed me your circular letter regarding the manufacture of coal gas, and suggested that I answer such questions as came under my personal observation while connected with the Saint Paul Gas Light Company. Without doubt, you will receive from Mr. Doty very complete replies, so I will confine myself to those questions dealing with the use of economizers.

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The fuel economizer of the Improvement Equipment Co. was placed in the Saint Paul plant a year ago last spring and was put in service shortly after my going with the Company in June. During the eight months of my service there, the economizers were largely under my control. The fuel used was gas house coke made from Pittsburg coal and had a calorific value of about 13300.

In the working of the economizer the fuel gases are drawn from a point near the entrance into the stack by means of an air injector, and driven under the grate, from which point they ascend through the grate bars, which are thereby cooled and on through the bed of fire where the CO_2 is reduced to CO.

The economizer is so built that each bench may be controlled independently; also, each bench has two injectors,—one on each side, which may be regulated independently.

The Improvement Equipment Co. claim that satisfactory results will be secured by the return of 25% of the flue gases under the grate. This, however, is not my experience with the remodeled benches in Saint Paul (Bredel & Parker-Russell). With a flue gas showing 15-17% CO_2, I found it necessary to have not less than 8% CO_2 under the grate, which means that 50% of the flue gases had to be returned in order to keep the grate cool and free of clinker.

I found that the proper balance necessary between the flue gases and secondary air, required a rather delicate adjustment of pressure, nozzles on the injectors, etc., and required some attention of such a nature that one not familar with the scientific principle upon which the economizer works, would be at a loss to correct the trouble.

Under intelligent supervision the economizer is of value. Heats may be brought up in about half the time required for benches fired in the ordinary way. The work dependent on the fireman is lessened to a marked degree in that little or no clinkering is required, since the fuel burns to a clean ash with only an occasional small clinker. One man can handle about twice as many benches so operated, as against those fired in the ordinary way.

In conjunction with a representative of the Improvement Equipment Co., Mr. Geo. Steinwedell and myself made com-

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parative tests of benches equipped with the economizer and those fired in the ordinary way. The actual figures I have not at hand, but the test showed a saving in favor of benches equipped with the economizer in point of fuel saved, labor required to maintain fires, etc.

Respectfully yours,

[Signed] R. M. REDDING,
Chemist."

A paper entitled "Bench Fuel Economies", by Mr. F. M. Richards, of Madison, Wisconsin, read before the Wisconsin Gas Association in 1907 (see American Gas Light Journal of May 27, 1907, p. 886) treats of the return flue gas method and the results accomplished by it. Unfortunately Mr. Richards does not tell us of all the factors entering into such a result. For instance, does he separately meter his coal gas, is the meter correct, how does he know that, etc.? It is very hard to accept results as worth anything unless all factors which may influence such results are considered, and covered by the paper.

In the discussion of Mr. Richard's paper the matter of the power required to introduce the return flue gases under the grates was brought into question. In regard to this point I can quote from a letter I received from Mr. E. Y. Sayer, General Manager of The Improved Equipment Company, of 60 Wall Street, New York City, under date of September 3, 1907, as follows:—

> "We have a small positive pressure blower having a capacity of five benches at Mattoon. This blower is direct connected to a vertical engine having cylinder dimensions of 4¼ in. × 5 in. They have a small 25 H.P. boiler which furnishes steam for the entire plant, operating the exhauster and blower. Nothing but breeze is used in the boiler and the boiler fuel amounts to 600 pounds of breeze per 24 hours. The steam pressure will vary from 60 to 80 pounds. The engine is a small, slide valve engine, and whereas we have never indicated it would imagine that it is developing something slightly over one H.P. It is operated at about 150 revolutions per minute,

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and certainly the mean effective pressure is not over 30 pounds per square inch. The air is delivered at 25 oz. pressure and this blower outfit is guaranteed to develop 5 lbs. air pressure with 80 lbs. steam. With a mean effective pressure of 30 lbs. you will see the engine is developing about 1.02 H.P.

I am going somewhat into detail about the power required to operate one of our air injectors for the reason that so much discussion has occurred on this point and apparently it is very much misunderstood by every one. We have in Denver thirty-six benches operating with the Economizer. Last year we installed ten new benches of 6's there that are every day carbonizing 7.2 tons of coal. The air is furnished to the injector at a pressure of from 25 to 30 oz. per square inch, which represents, allowing an efficiency of blower of 66.6 per cent., 0.249 H.P. per bench. Estimating 50 lbs. steam per hour per H.P. developed at the engine and an evaporation of 5 lbs. of steam per pound of boiler fuel, it requires 60 lbs. of boiler fuel per bench per day to operate the Economizer. This fuel is mostly breeze and cheap coal, which have a monetary value of about one-half *less* than that of coke. Therefore, calculated on a value basis it requires about 30 pounds of coke to operate the Economizer per bench per day of 24 hours. These are actual figures, and to substantiate their accuracy I am submitting our calculation.

If you will refer to a copy of 'Mechanical Draft' published by B. F. Sturtevant & Company, in whose catalogue No. 98 on page 148, table No. 91, you will find that the actual power represented by a jet of air under 15 oz. pressure per square inch, the nozzle having an effective area of one square inch, is 0.5518 H.P. By doubling this pressure, namely, 30 oz. per square inch, it represents an actual H.P. of 1.1036. We have benches operating in Denver where the nozzle is reduced to its smallest dimensions, namely: 7/16 in. Therefore the amount of air issuing from one of these nozzles would represent 0.166 of a H.P. The positive pressure blower companies guarantee 85 per cent. efficiency for their blowers, but for

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safety calculate that due to inefficiency of the blower and loss in pipe the actual power represented by the air at the nozzle would be two-thirds or 66 per cent. efficiency. This would indicate a continuous H.P. of .249. Allowing 5 lbs. evaporation per pound of boiler fuel and 50 lbs. of steam per H.P. hour of engine, this would represent 60 lbs. of boiler fuel per bench per day. The entire calculation is as follows:

15 oz. per sq. in. pressure (nozzle 1 sq. in.) = .5518 H.P.

$0.5518 \times 2 = 1.1036$.

Diameter — 7/16 in. = 0.15033 sq. in.

$1.1036 \times 0.15033 = 0.166$.

Consider $0.166 = 2/3$ power $\therefore 3/3 = 0.249$ H. P.

Allowing 5 lbs. evaporation and 50 lbs. steam per H.P. hour,

$$\frac{1/4 \times 50 \times 24}{5} = 60 \text{ lbs. of fuel.}$$

As a matter of fact at one of our plants where we have an electrically driven blower and there is in circuit with the motor a voltmeter and amneter, these results are verified.

We are going into a good deal of detail on this subject as it is important, and we would like you to be thoroughly familiar with this feature of the Economizer. At Mattoon, where they used to have direct-fired benches and their bench fuel was something over 500 lbs., we have cut the bench fuel at that plant in two, and when they get to using hot coke in their furnaces and running both benches at their normal capacity their bench fuel will probably drop to 210 lbs. We are extremely anxious for you to see one of our types of benches, and, if possible, would like to have you make arrangements to run a test on some one of our plants, possibly Mattoon, as it would be the most convenient to St. Louis.

After seeing the manner in which we handle the hot flue gases and the temperature they are introduced beneath the grate bars you will probably understand where we get the very high efficiencies that we are obtaining.

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In some of the trade journals, the blower required to operate the Economizer is referred to as a compressor. In no instance do we exceed 30 oz. of air per square inch, and some of our plants are running on 15 oz. per square inch. You will, therefore, see that the word compressor is not applicable. It is impossible to describe the difference in operation of one of our benches equipped with the Economizer and the ordinary type of bench. The installation partakes of a forced draft, which draft is under control and maintained at absolutely uniform pressure as we have an automatic pressure regulator keeping the pressure of air constant regardless of the amount of air required. The opening of the injector is controlled by a hand wheel and we have any amount of heat at our control that is necessary. The heats on the retorts are absolutely uniform and there are absolutely no clinkers whatever in our furnaces. In furnaces we have operated for four years, as far as can be ascertained from inspection, the linings are in as good a condition as the day they were started up.

We have only made one installation which is not satisfactory to us, namely: St. Paul. The reason for this is that we took some old benches that had been running for years, and by means of outside injectors endeavored to equip them with the Economizer. Just what results have been obtained at St. Paul we do not know. However, we are informed that it has stopped the clinkers and makes some considerable saving in bench fuel. Since then we have entirely abandoned trying to equip old benches with the Economizer. For this reason the St. Paul plant may not be entirely satisfactory. All others of our plants seem to be giving very satisfactory results."

The foregoing comprises about all available information on the subject of the return flue gas method of bench operation in the United States that I was able to secure to the date of this writing. I may add that I have a copy of the Improved Equipment Company's instructions for operating their so-called economizer, but this falls within the realms of trade

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literature, and should readily be obtainable by any one writing for a copy. I will, therefore, omit it from this paper.

CONCLUSIONS AS TO VALUE OF RETURN FLUE GAS METHOD.

It is difficult at present to speak with absolute certainty in regard to the value of this method. From a standpoint of the purely theoretical considerations of the thermo-chemistry of the case, it would appear from Dr. Fischer's figures hereinbefore presented that the method is not economical as compared to the method of introducing water vapor properly preheated. The statements in Dr. Fischer's book are so positive that I would hesitate very much to accept any contrary views at present. They have evidently worked on various return flue gas installations abroad for a number of years.

At the same time the history along this line in this country is altogether insufficient to allow us to base conclusions upon it. The advocates of the return flue gas method claim its superiority over the introducion of water, by stating that large quantities of water must be used to keep down the formation of clinker, and because of the high specific heat of water vapor they say a great deal of heat escapes from the stacks. It appears to me, however, that we are not using water vapor properly, and when we learn to do that we will be able to accomplish much better results than heretofore, and very likely better than can be obtained by the return flue gas method.

I would suggest that benches be so designed that both the primary and secondary air be preheated as well as the water vapor, and that the primary air be so arranged that there will be an absolutely homogeneous mixture of it with steam. In that way excessive quantities of water will not be required. I understand one large plant in this country introduces steam under the fire by capping up the end of the steam pipe and drilling a small hole through the cap of the right size to introduce the proper quantity of steam under the average boiler pressure maintained at that plant. This required some experimenting, but now the stokers and other men can not alter the quantity of water vapor introduced, and it looks like a very good and simple solution of the problem to me.

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I wish to call attention to one additional factor which appears to have some influence on the choice between water vapor and return flue gas. On page 145, "Beilage zum Chemiker-Kalender," for 1902, we find the heat of formation of combination of hydrogen and oxygen at various temperatures as follows :—

		Gaseous.	Liquid.
Water — $H_2 + O = H_2O$ at	0° C	+ 58.3	+ 69.0
" — " = " "	2000° C	+ 50.6	
" — " = " "	4000° C	+ 37.1	

On page 151 of the same book we also have the heat of formation of combination of carbon monoxide and oxygen as follows :

$CO_2 - CO + O = CO_2$ at	15° C	+ 68.3
" — " = " "	3000° C	+ 37.0
" — " = " "	4500° C	+ 28.0

From these exothermic reactions we can draw from the foregoing that at increasing temperatures the heat of formation of H_2O falls off less rapidly than that of CO_2 from CO.

If, therefore, Dr. Fischer had used the proper heats of formation at the various temperatures, it would appear that the difference in favor of the use of water vapor would have been still greater than shown by his figures.

One more point is worthy of attention. If table No. 6, page 13, of the 1906 edition of Emilio Damour's "Industrial Furnaces and Methods of Control" is correct, it would appear, by taking molecular equivalents, that the loss of heat of water vapor escaping from the stack from 1400° C. down to 0° C. is less than the loss of heat of CO_2 with its accompanying nitrogen from 1400° C. down to 1000° C. Therefore, from a standpoint of the efficiency of heat transmission from carbon to gaseous fuel, the heat carried off from the combustion chamber is less with water vapor than with CO_2 and its accompanying nitrogen.

When the advocates of the return flue gas method lay so much stress upon the high specific heat of water vapor as compared to CO_2, or nitrogen *per unit of weight*, they evidently forget that the specific heats of these substances when compared on a basis of molecular equivalents is practically the

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same, with that of CO_2 somewhat higher. For instance, see table 7 of Damour's book, page 13.

Molecular weight of CO_2 = 44

Molecular weight of H_2O = 18

From the table at 1000° C. the thermal capacities are as follows:—

H_2O — . 609 per Kg.

CO_2 — 277 per Kg.

Thermal capacity of

44 Kg. CO_2 = 44 x 277 = 12188

18 Kg. H_2O = 18 x 609 = 10962

From Dr. Fischer's equations 3 and 4, which are

$C + CO_2 = 2\,CO$ = — 39000 Cal.

$C + H_2O = CO + H_2$ = — 39400 Cal.

we see that molecular equivalents of CO_2 and H_2O are used per atom of carbon. From this the loss of heat of water vapor escaping from the stack (even with the high specific heat of water vapor) is not serious in comparison with similar losses due to CO_2 and nitrogen.

The burden of proof is apparently up to the advocates of the return flue gas method. If they can apply their proposition to a plant which is generally accepted as being operated competently, and where the gas is separately metered, where the coal carbonized is properly weighed, and where, in general, all the factors entering into the results are properly taken care of, then we can begin to secure an idea of what they can accomplish. On the other hand, I am perfectly satisfied that the use of water vapor or steam has by no means found its ultimate development, and there is no question that the bulk of plants would be considerably improved in results if they were subjected to strict examination and overhauling; that is, I believe present results, even with present apparatus, are far below what they should be.

One other important point is worthy of notice. It seems to be the prevailing opinion that primary air should not be preheated. Such an assertion looks utterly illogical to me—a deliberate waste of heat. No matter what concurrent arguments may be applied, some correct method of utilizing preheated primary air should be found.

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It is right here that the advocates of the return flue gas method, unconsciously perhaps, score a point over the ordinary bench. They introduce their primary air in mixture with hot waste gases, thus really preheating the primary air by actual contact with the heating medium, and under conditions of the highest efficiency, the same as in a steam jet condenser where the highest heat transmission efficiency from steam to water is reached by actual contact. I would not be at all surprised if a considerable portion of the economy claimed, results from this preheating of primary air.

There can be really no good reason why a bench can not be designed to use water vapor properly, and to preheat both primary and secondary air, and then, if Dr. Fischer is right, it would result in a more efficient bench than the other type. In fact I believe such benches have been in use a long time in Germany and elsewhere.

To be sure, clinker formation is certainly prevented by the return flue gas; but if this is accomplished at the expense of fuel economy, why do it in that way? Then, too, the question of saving in repairs is in that state where no data is available whatever.

I am inclined to believe that the facts presented so far, would, to say the least, make me desire much better proof than is heretofore presented, before I would concede the superiority of the return flue gas method of operating recuperative benches, over a proper method with water vapor.

We can at present readily see, however, that this agitation in regard to bench economy will surely result in good. The electric light resurrected the gas business from 99.44% of stagnation, and while the percentage may not be so great, let us hope the flue gas method will stimulate us all to much greater efforts (and consequently benefits) in our recuperative bench design and operation.

RESULTS AT VARIOUS PLANTS AS REPORTED IN ANSWERS TO THE ONE HUNDRED QUESTIONS.

One of our most prominent young gas managers made the following remark to me recently:

"I believe that we have got to get back, a little at least, to the

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old idea that there is a great saving to be made in the retort house. Some of our enthusiastic fellow gas men have been talking other things so long and so loud that their retort houses won't bear inspection."

A similar idea, coupled with the desire for actual facts, was one of the factors which led to my sending out a list of one hundred questions relating to retort house practice. Altogether we sent out about 750 lists, and out of these have to present herewith the answers from about forty Companies. It seems a little odd that it should be so hard to get people to send in answers which are intended to result in good for all.

At first I endeavored to combine the answers into one general table, but this now appears unsatisfactory. There is a great deal of valuable information in each set of answers, and I have therefore decided to insert them in full. In the following pages you will find :

First, the list of 100 questions ;

Second, the complete answers of all Companies reporting arranged in groups according to types of benches, and the Companies being numbered, not named ; and,

Third, a résumé of the important results of operation, being in general the averages of certain sets of answers for each group of reporting Companies.

LIST OF ONE HUNDRED QUESTIONS.

1 What number and type of recuperative benches have you in your plant ?
2 Who built these benches ?
3 What is the average number of these benches you have operated in the last twelve months ?
4 Give the dimensions and number of retorts per bench ?
5 When were the benches you operated during the past twelve months completely refilled, and what was their average physical condition during this time ?
6 When were the benches you operated during the past twelve months refilled above recuperators, and what was their average physical condition during this time ?
7 Give grate area of the furnace ?

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8 State depth in feet and inches from top of top recuperator to bottom of bottom recuperator?

9 Give vertical distance from grate bars in furnace to top of chimneys for escape of products of combustion?

10 State average depth of fire in furnaces, as near as you can determine it?

11 What kind of gas coal did you use during past twelve months?

12 Give average yield of gas per pound of coal carbonized during past twelve months, corrected to 60° Fahr., and state if you also correct to 30″ barometer?

13 Do you separately meter your coal gas?

14 Is your coal gas mixed with water gas before it is metered?

15 Have you no station meter at all?

16 If you have separate coal gas station meter, state its size, kind of drum and maximum rate per hour at which you passed coal gas through it during last twelve months?

17 When was such coal gas station meter last tested?

18 What is your idea of the average accuracy of this coal gas station meter during last twelve months? Why?

19 What was the average amount of coal carbonized per active retort in last twelve months per twenty-four hours?

20 What was average candlepower of your coal gas during last twelve months, corrected to 60° Fahr., and 30″ barometer?

21 What was average net B. T. U. of your coal gas during past twelve months?

22 What was percentage of active retorts to total number of retorts under fire during past twelve months; in other words, what percentage of idle retorts could we figure on in your plant, owing to scurfing, etc.

23 What kind of bench fuel did you use during past twelve months?

24 What was its average calorific value?

25 What was the average proximate analysis of this bench fuel, as nearly as you can give it?

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26 How many pounds of this bench fuel did you use on the average during the past twelve months per ton coal carbonized? (Figure ton as 2,000 lbs.) How do you obtain this figure? Is bench fuel actually weighed? How?

27 How many pounds of water and steam per 100 lbs. bench fuel did you run into ash pan and under fire during past twelve months? If you do not know, please make an hour's test and insert result from that.

28 Did you have any excessive clinkering to do? Explain.

29 Are you returning any portion of the waste flue gases under the fire?

30 Where are these waste gases taken off?

31 What was their average temperature at this point during past twelve months?

32 What was their average chemical composition during this time?

33 What percentage, by weight of total waste gases, did you return under fire?

34 What percentage, by weight of total air and gases mixed, going under the fire, was this waste gas thus returned?

35 What average percentage, by weight of CO_2, was there under your fire during last twelve months?

36 Did the use of return flue gases enable you to dispense with water or steam under the fire and thus secure as little or less trouble with clinkers? Explain.

37 What saving in bench fuel, per ton coal carbonized, resulted from the use of such a scheme?

38 What labor saving resulted?

39 Did your results vary any from what they were prior to introduction of such a system? Explain fully.

40 What differences did you observe in the operation of the benches thereafter?

41 What repairs to the bench were caused by introducing those waste gases under the fire, if any?

42 How many pounds of water or steam did you save, per 100 lbs. of bench fuel, while returning these waste gases under the fire?

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43 Was it necessary to use any water or steam under the fire at all during operation with these waste gases?

44 Was the temperature of the stack gases raised or lowered when using these waste gases?

45 How do you deliver these waste gases under the fire?

46 How does your retort house foreman regulate the amount of these waste gases?

47 How does your retort house foreman know when he has reached the proper amount of waste gases he desired to introduce under the fire?

48 Is the regulating of the waste gases accomplished on each individual bench, or so arranged that it handles a complete stack?

49 Have you any determined method of obtaining the proper amount of waste gases required? If so, explain.

50 Is the regulation of these waste gases very difficult or simple? Does it have to be watched very carefully?

51 In figuring a saving resulting from the use of a portion of the waste gases under the fire, did you take careful consideration of all the factors entering into such a result, such as yield of gas per lb. coal carbonized, etc.?

52 From your experience, do you believe there is any real value in using the return flue gas scheme? Explain. Or would you stick to the older method of introducing water and steam under the fire? Why?

53 In ordinary bench operation (not considering any return flue gas scheme), how do you regulate the proper amounts of primary and secondary air?

54 Do you think of any satisfactory way whereby an average retort house foreman could regulate his bench heats and air openings except by chemical analysis of the waste gases? Explain.

55 How many days, after an entire new stack of benches is completed, do you consider it necessary to heat it gently before bringing it up to full heat for regular operation?

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56 How many days after a bench is refilled from the ash pan up, do you consider it necessary to heat it gently before bringing it up to full heat for regular operation?

57 How often do you think it wise to scurf retorts? State answer in days.

58 How many hours would you allow for scurfing a retort, and how would you do it?

59 Do you think a bench should ever be let down except for repairs, if you can so arrange your operation to make this possible?

60 How would you clean flues so as to injure a bench as little as possible?

61 How would you clinker and take out ashes so as to injure a bench as little as possible?

62 How would you put in coke as bench fuel so as to insure best results and injure a bench as little as possible?

63 How would you put in coal as bench fuel so as to insure best results and injure a bench as little as possible?

64 Would you use water, steam or flue gases under the fire? Why?

65 How would you draw and charge your retorts so as to injure them as little as possible?

66 Would you quench your coke by throwing water on it as it lies on floor or in conveyors or chutes in front of bench, taking into account the injurious action on the bench of having water thrown on the hot brick?

67 Would you keep dust off top of stacks, tar off the mouthpieces, etc., in order to prolong the life of the benches?

68 Would you allow your chemist to regulate your heats in preference to any other method?

69 How often do you fire your furnaces?

70 Have you any method of preventing the cooling of the bench when clinkering or firing?

71 If you have any such method, does it work automatically? Explain.

72 Do you operate your bench with a high heat or medium? Consider above 1500° Cent. high heat in combustion chamber?

Give degree of heat, if possible.

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74 Is it advantageous or disadvantageous to operate your bench under such a heat?
75 State these advantages and disadvantages?
76 Have you any flame coming out of the stack?
77 When this is the case what do you do to remedy it?
78 Have you much trouble with stopped stand-pipes?
79 To what do you attribute this trouble?
80 Would you advocate using a separate producer for firing a stack of benches if your retort house is large enough?
81 What would be your reason for advocating the above?
82 Why would you advise against it?
83 How often do you clinker?
84 When do you clinker or fill your furnaces? Just before the draw or after the draw?
85 Do you charge your retorts by hand or by machinery?
86 How long are your lids off of the mouthpieces? (Take the time from the beginning of the draw until the end of the charge.)
87 How do you control the primary air you admit? Explain.
88 Whom do you allow to regulate the primary and secondary air? The retort house foreman or any of the stokers?
89 Do you preheat your secondary air? How many degrees Cent.?
90 How do you introduce your water or steam into the ash pan?
91 Do you keep a record of the performance of each bench?
92 Why?
93 What kind of refractory material have you found to be the best for bench construction?
94 If you have inclines or verticals, please state briefly how you regulate your heats, clinkering and clinker prevention, and whether you find any difference in these respects as against ordinary retort house with horizontals?
95 Do you introduce any air into the coal gas prior to the station meter?
96 When do you introduce this air?
97 What per cent. of the total coal gas made, corrected to 60° Fahr., is such air?
98 Do you preheat such air?
99 If so, to what temperature?
100 Why do you preheat it?

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
1	60	20	16	10	7	7
2	42 Parker-Russell 18 Bredel	Parker-Russell	Parker-Russell	Parker-Russell	Parker-Russell	Parker-Russell
3	53	14	All	All	7	All
4	16 in. x 24 in. x 9 ft. 1 in.	16 in. x 28 in x 9 ft. 4½ in.	16 in. x 26 in. x 9 ft.		Top and Center, 16 in. x 28 in. x 9 ft. 6 in. Bottom, 16 in. x 26 in. x 9 ft. 6 in.	Bottom, 16 in. x 26 in. x 9 ft. 5 in. Others, 16 in. x 28 in. x 9 ft 5 in.
5			Not Refilled	Not Refilled	9/11/06, First-Class	4-February, 1904, new. 3-October, 1905.
6						
7	11.88 sq. ft.	5 ft. 3 in. x 30 in., 13.12 sq. ft.	29½ in. x 60½ in., 12.39 sq. ft.	2 ft. 6 in. x 4 ft., 10 sq. ft.	2 ft. 6 in. x 4 ft. 6 in., 11.25 sq. ft.	3-11.25 sq. ft. 4-10 sq. ft.
8	9 ft. 6 in.	7 ft. 7 in.	9 ft. 10 in.	5 ft. 3 in.	10 ft. 8 in.	10. ft. 4 in.
9	29 ft. 11 in.	30 ft. 5 in.	50 ft.	Common flue into boiler stack.	94 ft. 4 in.	36 ft. 2 in.
10	4 ft. 6 in. to 5 ft. 0 in.	4 ft. 0 in.	5 ft. 0 in.	4 ft. 6 in.	4 ft. 0 in.	5 ft. 0 in.
11	West Virginia.	Mixed Tennessee, Kentucky and Alabama.	½ Fairmont, ½ Pool Yough.	Mostly ¾ Yough.	½ Kanawha, ½ Yough. (¾)	Manor Gas Coal Co. ¾ Screen.
12	4.85 Corr.	4.56 Corr.	5.039 Corr.	4.75 Corr.	4 94 Corr.	4.98 Corr. for Temp. only
13	Yes	Yes	Yes	Yes	Yes	Yes

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
14	No	No	No	No	No	No W. G.
15			We have three.		We have two.	
16	14 ft. 4 Partition. Sta. A 140 M, Sta. B 75 M.	9 ft. Hinman, 60 M.	½ Proportional, 75 M. 12 ft. 20 M, 10 ft. 55 M.	14 ft. Hinman, 42 M.	10 ft. Maryland drum, 30 M.	10 ft. Old Style, 38 M.
17	Once per Year	8/2/'07	Prop. once each month; drum every year.	July, 1906	1/8/'07, 1/11/'07	July, 1904
18	Accurate within ½%	1% fast	Accurate	Accurate	One .4% fast. One 1.5% slow.	Correct
19	1902 lb.	268 lb.	467 lb.	2064 lb.	2160 lb.	2261.6 lb.
20	14.35	13.6	15.26	13.8	16.8	
21	615 gross. Average of tests made	Not determined	602 gross	About 590		600
22	98%	95%	95%	1½ retort off per day 98%	66.62%	98.7%
23	Coke from retorts hot as drawn.	Hot Coke	80% GasCoal, 20%Coke	Coke.	Illinois Coal, R.O.M.	Coke from retorts
24	Do not know	Not determined	13,500 B. T. U.	Don't know	10,757 B. T. U.	
25	Moisture 00, Vol. Mat. 2.16, Fixed Carbon 86.93, Ash 10.91	Moisture 1.00, Vol. Mat. 2.00, Fixed Carbon 87.00, Ash 10.00	Coal Coke Moisture .07 10. Vol. Mat. 35.7 } 80. FixedCarb. 58. } Ash 4.5 10. Sul. 1.1	Do not know	Moisture 12.20, Vol. Mat. 35.90, Fixed Carbon 37.50, Ash 14 40	

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
26	275 lb. Bu. dry coke at 38 lb., Bu. dry breeze 45 lb., Bu. hot coke 34 lb.	315 lb percentage of coke determined by wt. for any given coal.	Coal 209.2 lb. Coke 65.6 lb.	270 lb. by tests carefully conducted. We do not weigh constantly.	441 lb.	280 lb. weighed periodically for 3 or 4 days at a time.
27	25 lb. steam. 30 lb. water.	200 lb.		Use water only	3 gal. per hour.	•
28	Clinker every 24 hours, use sufficient water and steam to keep fire in good condition for clinkering.	No.	No.	No. Poor coal causes some trouble.	At rare intervals.	No. Clinker each bench with supplementary bars inserted twice per week.
53	Regulate primary and secondary air so benches will heat properly with 1% oxygen as max. and burning proper amount of bench fuel and proper heat in recuperator.	Open primary air enough to cause sufficient flue gas to give desired heat in bench. Open secondary air enough to do away with blue flame in recuperator.	First by analysis of waste gases. Open primary to make enough gas to heat bench and secondary to burn off these gases.	Observation of flues, color of setting, etc.		Open primary air to properly carbonize the coal. Open secondary air to point at which no flames are in recuperator.
54	Cannot be done with economy without analysis.	Follow above method. Chemical analysis too expensive.	Throw lump of coal in waste gas flue and watch by sight hole covered with glass. Heat should just consume gas from coal.	Know of none.	Manipulate fires properly.	Same as 53.
55	5 weeks or better 6 weeks.	6 weeks.	3 weeks.	6 weeks.	About 2 weeks.	2 weeks.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
56	1 month at least.	If benches surrounding have been in operation 10-14 days. If not, 3 weeks.	2 weeks.	2 weeks.	About 10 days.	10 days.
57	Scurf sufficient to keep size up.	30 days.	Depends on condition of retorts, coal, backpress., etc., on average 30 days.	60 days.	6 weeks.	75 days.
58	14 hours Scurf with steam and compressed air.	20-30. Use steam only.	12 hours. Jet blower using compressed air and steam.	12 hours. Scurf with steam and air.	4 hours, using air blast.	When new, 4 hours. Use 6 in. W. I pipe with ¼ in. steam injector. Steam superheated by passing through ¾ in. pipe coil in retort.
59	No. It cannot be done without injury to setting.	No.	If it needs repairs, yes.	No.	No, except for repairs of some extent.	No.
60	Have a scraper and use carefully.	Remove stoppers at end of flues and scrape out dust with the hooks as quickly as possible. "Water cure" not harmful for plugged flue, if not carried to excess.	Blow out with compressed air.	Close dampers on side being cleaned and clean flues with hoe, or blow out with steam.	Close back damper	Clean only 2 or 3 flues at one time, allowing time for bench to recover from cooling effect. After cleaning examine for leaks and repair any found.
61	Clinker before and near the puddling hour; use temp. bars take out clinker in middle, then cut off clinker on sides carefully and take out.	Insert secondary bars above clinker, remove pri bars cut out all clinker from top, back and sides, replace primary and remove secondary bars, and clean ash pans.	Use false bars, keep a deep bed of fuel above same.	Do both in shortest time possible and with as little loss of coke as possible	Use false bars which retain 3 to 4 ft. of fire. Bench not cooled down much due to fire above false bars.	Have fire full, insert supplementary bars. Have 2 men on each bench.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
62	Put in from middle retorts. Shove back with long-handled poker.	When middle retorts are drawn charge hot coke directly into furnace.	Draw in hot from retort.	Charge furnace fairly often and quickly; level off charge.	By using a chute to carry hot coke direct from center retorts.	Draw hot coke from retort into fire, feeding as often as there is room for one retort of coke, shoving back coke well to carry a level fire.
63	Do not do it.	Never used coal as fuel.	Put in front of bench, and then push back in an hour; after coal is partially coked.		Use automatic feeder only.	Fire frequently, say every half hour, in small quantities, keeping fire level and full. Break up fire at top before firing.
64	Use water and small amount of steam if needed to keep clinker soft.	Water least expensive and equally effective.	Exhaust steam and water.	We use water; never tried flue gas.	Steam to soften clinker.	Water cheaper than steam at this plant, and does the work as well.
65	With a Bronder machine.	By hand. Machine just as effective, but tends to injure bench		Depends entirely upon equipment and personality.	By hand.	By hand.
66		Quench in hoppers placed directly under operating floor does away with steam in retort house, water on fire brick work and damage of fire in storage bin.	Chutes or platform in front of bench.	Quench in chutes.	Quench in chutes in front of benches.	In chutes.
67		Yes.	No, but to improve general appearance and for effect on men	Yes, for many reasons.	Not necessarily.	Yes, and for other reasons.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
68	Chemist advises foreman, who uses information. Chemist is advisor — not operator.	No (and I myself am a chemist at that).	No.	No.	Not necessarily.	No.
69	Puddle every four hours, to keep furnace as full as possible.	4 hours.	2 hours.	Every 4 hours.	Every 2 hours.	2 hours.
70	No. It does not cool in such a short period.	None except to get both jobs done as quickly as possible.	Properly fired or properly clinkered, bench will not lose heat to any extent.	No.	False bars in clinkering.	No.
71						
72	Heat to give a yield of about 4.75 to 4.85. This is about 1750° in retort with 4 hours charges of 320 lb.	(1) 2200° F. (2) Yes.	Medium.	Medium to low.	High heat, yes.	Medium, yes.
73	This heat is taken with an electric pyrometer between charges. Not used practically.	2200° F.	1250° C to 1350° C.		1232° C our test.	
74	Advantageous, good residual and good candle ft.	Advantageous.	I think advantageous.	Think it advantageous.	Advantageous.	Advantageous.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
75	Ammonia results and bench fuel results suffer with too high heat. Coke quality suffers with lower heat.	All coal that can be charged by hand can be completely burned off and yet heat so low no possible injury can happen to settings.	Long life, good tar, fair ammonia yield.	Longer life to bench, less trouble in house, higher C P.	Better coke, increased make per bench, increased yield. Disadvantage: napthalene formation and stopped stand pipes.	
76	No.	No.	No.	Not here. Individual stacks. Would be some flame after filling furnace.	None.	No.
77		Patch retort that has hole in it.			None.	If blue flame, deficienoy of secondary air
78	None whatever, use pneumatic standpipe cleaner.	No.	No.	No.	Not as a rule if properly attended to.	No.
79					Too light a seal. Carrying too much vacuum. Stack cool with excessive heat.	Regularity of exhauster and large charges, having small heating surface of retort, hydro-carbons decomposed.
80	Such practice with low grade fuel might effect considerable saving.	Yes.		Don't know.	Can't state—if low grade of coal was used, yes.	No.
81		Economy.			Saving in fuel if low grade was used.	

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
82						Not economical, due to loss in transmission of heat. Irregularity of producer would have farreaching effect on all settings.
83	Once in 24 hours. Time 15 minutes.	Once in 24 hours.	Once in three days—bar and hook out every day.	48 hours.	Once in 24 hours. Break up fires every 4 hours.	Twice per week.
84	Do not set time. Benches clinker in rotation. Try to regulate it before puddling.	Clinker just before draw. Fill furnace at time of draw.	Before and after.	During draw.	Before and after.	Just before draw.
85	Machinery.	Hand scoops holding about 170 lb. apiece.	Part by machine and part by hand.	Hand.	By hand.	By hand.
86	Lids open 4 minutes. No not open all at once.	10 to 15 minutes.	By machine 3 min. Hand 8 min.	3 to 5 minutes.	10 minutes.	In summer, 5 to 7 min.
87	Primary air admitted thru sliding adjustable shutter.	Opening and closing slides in primary air openings in settings.	By port openings.			
88	General foreman. One man entirely responsible.	Foreman only.	Foreman only.	Supt. or Asst. Supt. No.	Supt. or Asst. Supt.	Supt.
89	Only by recuperation. Temp. approx. 1900° F.	No.	Yes.	Yes. Don't know.	800° to 600° C.	Yes. No data.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 1—*Continued.*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
90	Water runs into ash pan by sight feed. Ash pan has overflow—sight reg.	Trickles down over water plates placed above grate bars.	Water on water table above clinker door; steam jet under middle of grate bars.	Small water pipe over water pan upon grates; running steady.	Water dripped slowly upon drip bars; steam admitted under grate bars.	Small stream of water falls on water plate and drips into ash pan.
91	Yes.	Yes.	No.	No. House too small.	Yes.	Yes.
92	Each bench run as a separate unit. Record of bench fuel very important. Bench must run certain time or we must know why not.	For comparison, so as to detect leaks.			To ascertain accurate results.	To aid in keeping up eff. of each to gen. standard.
93	Parker-Russell and Cyrus Borgner	Parker-Russell.				Parker-Russell.
94						
95	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.
96	Inlet to condensers.	At exhausters.	Inlet of exhauster.	Inlet exhauster.	Inlet exhauster.	Hydraulic main.
97	1½ to 2%.	2% to 2.5%.	1½%.	1%.	1½%.	
98	No.	No.	No.	No.	No.	No.
99						
100						

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2.

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
1	10	5-Inclines	22 8 Parker-Russell 6 Strecker 8 Klonne Bredel	22 Parker-Russell	5-Inclined	28
2	Parker-Russell 8 Laclede 2	Bartlett-Hayward & Co. Didier	14 by P. R. Foremen 8 by works foremen.	Parker-Russell	Bartlett-Hayward Stetting	20 Bredel. 8 Parker-Russell.
3	7.9	4	18	10	4	18
4	9 per bench 6—16 in. x 26 3—16 in. x 24	15 in. x 23½ in. x 20 ft. 0 in., 9's.	9 per bench 16 x 26 x 9 ft. 16 x 24 x 9 ft.	Bot. 16 x 23½ x 9 ft. 6 in. Mid 16 x 26 x 9 ft. 6 in. Top 16x26 x 9 ft. 6 in. (9's)	16 x 22 x 18 ft. 0 in.	16 x 26 x 9 ft. 4 in.
5	4—6 years ago 4—5 " " 2—4 " "	New 1905; started, Oct. 1905	10 new 1905. 4 refilled from floor line 1906. All good	1902 good	Average life about 900 days	12 re-filled years ago. Were burnt out
6	6—1 year ago 2—4 " " 2—3 " "			1905 good	All work done in 1903	12—3 years ago. 18—2 years ago.
7	About 10 sq. ft.	14 sq. ft.	11.25 sq. ft.	9.58 sq. ft.	15 sq. ft.	8.88 sq. ft.
8	8 ft. 2 in.	13 ft. 1½ in.	9 ft. 7 in.	6 ft. ½ in.	10 ft. 5 in.	10 ft. 0 in.
9	About 35 ft.	125 ft.	62 ft 5 in.	30 ft.	126 ft.	29 ft. 0 in.
10	About 4 ft. 0 in.	5 ft.	6 ft. when full. Kept as full as possible.	5 ft.	6 ft.	4 ft. 0 in.
11	Youghiogheny	Westmoreland	Westmoreland, Lincoln, W. Va. Youghiogheny.	Youghiogheny gas lump.	Penn.	Penn, Pittsburg, Westmoreland.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
12	4.69 Corr.	4.75 Corr.	4.90 Corr.	4.79 Corr.	4.77 Corr. for temperature only.	4.75
13	Yes	Yes	Yes	Yes	Yes	Yes
14	No	No	No	No	No	No
15		We have station meter.			Have 2	Have 5
16	14 ft. Hinman drum.	12 ft. Hinman, 45 M.	63 M, 12 ft Parkinson.	15 ft. drum, 70 M.	16 ft. ordinary wet meter 35 M.	
17	Within a year.	February 1907.	October 1906.	1905	1902	
18	Correct	Believe it to be correct.	Correct on basis of above test.	O. K.	Correct	
19	2094 lb.	4625 lb.	1800 lb.	2262 lb.	3650 lb.	1750 lb.
20	15.47	15.00	14.63	14.98	15.8	15.45
21	Not taken.	Don't know.	Not determined.		Not taken.	618
22	98.2%	97.6%	94%	97.3%	99%	97%
23	Coke	Coke	Coke from Retorts.	Gas House Coke.	Coke	Hot Coke.
24	Not taken.	Don't know.	Not determined.	13,250 B. T. U.	Not taken.	
25	Vol. Mat. - 6.00 Fixed Carbon 85.00 Ash - - 9.00	Moisture - .97 Vol. Mat. - 5.26 Fixed Carbon 83.68 Ash - - 10.09 Sulphur - 1.00	Ash 12% to 15%	Fixed Carbon 90.21 Sulphur - .81 Ash - - 8.98	Not analyzed.	

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
26	283.8 lb. per ton obtained by knowing number of retorts whose output of coke is used for bench fuel. It is not weighed.	280 lb. Occasional test by actual weight.	298 lb. Tests show that about 23% of coke made is used and our total coke is about 66% by weight of coal carbonized.	251 lb. Figured from number of retorts of coke drawn into the fire. It is considered that the total coke is 65% of coal carbonized.		22% of coal carbonized.
27		Use live steam and water. Cannot tell how much.			Steam and water mixed.	
28		No	No	No	No	No
53	By appearance of waste flue gases.	Make as much gas as required, and give it enough air to burn it. Observe waste gases.			By air slides.	By temp of retorts.
54	Yes, by practice proper results are small blue flame at 2nd flue above dampers. After proper adjustment can be regulated by dampers on top of stacks.	Have enough pressure under top of arch to make gas back out, and if it burns in a blue flame give enough sec. air to make it disappear and then cut it down just a little.			Regulate fuel burned by primary inlet and main damper. Regulate combustion by secondary inlet.	
55	60 days.	42 days.	21 to 28 days, or at least till steam stops coming from vents.	14 days.	45 days.	15 days.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
56	10 days in warm weather.	14 days.	10 days having retorts showing red at end. Keep for 2 or 3 days, then bring to full cherry, and charge lightly.	10 days.	10 to 12 days.	10 days.
57	As soon as any carbon appears in retort.	Depends on back pressure, in our case 30 days.	12 days.	30 days.	No scurfing except to hold charge out 5 to 7 min.	
58	4 hours.	5 to 10 hours. Open top lid wide and lower lid about 2 in. until carbon loosens, then remove with bar.	About 6 hours. Induce current of air to back of retort.	7 to 8 hours.		6 to 10 hours steam and air.
59	No	No	No	No	No	No
60	Scrape them	No. Cut down draught.	No. Open ends of flues, one at a time. Use light, handy tools. Get flues closed again as soon as possible. Don't let them get too dirty.	No. With small hoe made especially to fit.	No. Close back dampers; work rapidly.	
61	Using false grate bars.	Insert false grates.	Try to have as little hard clinker as possible by using water and steam, and not carrying an excessive heat in fuel bed. Use false bars. Get clinker out, furnace filled and door shut as soon as possible.	Keep fires so it is necessary to clinker once in 48 hours. Use supplementary bars.	Secondary bars.	Temporary fire bars; do it as quickly as possible.

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TABLE 1—SO-CALLED FULL DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
62	Every 4 hours direct from central retort.	Hot	Draw *hot* from retorts into furnace using little or no water — keep furnace full.	Draw hot coke direct from retorts into fire.	Hot coke.	With hot coke when drawing retorts.
63		Don't know.				
64	Water and steam.	Enough to prevent formation of clinker.		We use water and steam to get the best results.	Steam	Water and steam.
65	Use care in operation.	Draw and charge as quickly as possible.	Make operation as short as possible. Use tools that will not damage retort.		Without machines.	Draw and charge with machine.
66	Have quenching tank under floor and dump into buggies or onto conveyor cold.	We quench in the conveyor.	Would quench away from bench, letting no water touch hot bench if possible.		Away from bench.	Coke quenched in conveyor.
67	Yes	Yes	Think dust does no harm and acts as a non-conductor. Keep mouth-pieces clean at all times.	Yes	Yes	Yes
68	No	No	No	No	No	
69	Every 4 hours.	5 hours.	5 hours normally—whenever necessary, if fire is low after clinkering or for any other reason	4 hours.	2 hours.	5 hours.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
70	No	False grates.	No	No, except to clinker and fire as quickly as possible.	Secondary bars.	No
71		No			No	
72	Fairly high heat.	High	Medium	Medium	Medium	Medium
73		3000 F.			1800 to 2000 F.	
74	Advantageous	Advantageous	Advantageous		Advantageous	
75		Better yield per lb. per retort per man.	Tar and ammonia injured less by this heat, C. P. better, coke larger and benches and retorts last longer.		Higher yield and medium C. P.	Reduction in amount of lamp black.
76	No	No	No	No	No	No
77	Stop leaks in retorts.	Patch retorts.			Adjust dampers.	
78	No	No	No	No	No	No
79	To the stoker.	Badly kept cleaning tools.				High heat.
80	Do not.	Yes	Not unless the design is such as to utilize the sensible heat of the furnace gases.			Yes
81		Saving of fuel.				
82						

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TABLE 1—SO-CALLED FULL-DEPTH 9's - PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
83	48 hours.	24 hours.	48 hours.	48 hours.	24 hours.	24 hours.
84	Before	4 fires cleaned once in 24 hours in forenoon. Filled 10 times in 24 hours.	Clinker just before draw. Fill during draw.	During the draw.	Before	Fill at draw, clinker before draw.
85	Hand	Inclined charging chute.	Machine	Hand	Gravity inclines.	Machinery
86	3 minutes.	2 minutes.	10 minutes.	5 minutes.	5 minutes.	2½ minutes.
87		By amount of CO required.	Small sliding door at inlet of air duct.	Dampers on each side of clinkering door.		Slide damper.
88		Retort house foreman.	Works foreman under direction of Sup't.	Retort house foreman.	Foreman	Foreman
89		2000° F.	Yes. Degree not determined.			Yes
90		Is mixed with primary air.	Water enters sight feed at top of clinkering door, flows to pan, whose length equals width of furnace — overflows onto stepped grate; finally drips from ends of grate bars to ash pan. Steam introduced into ash pan water.		Overflow of water and steam from boiler into ash pan.	Above furnace door.

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TABLE 1—SO-CALLED FULL-DEPTH 9's—PART 2—*Continued.*

	No. 31	No. 32	No. 33	No. 37	No. 40	No. 42
91		No	Only of draft setting, and days bench has worked. Approx. coal charge and retorts scurfed.	Yes	Yes, as to fuel, coal, life, etc.	No
92		Cannot				
93	St. Louis	Didier	Didier for combustion chamber.	Parker-Russell	Foreign	Glenboig
94		Regulate heat with baffle plates. Introduce enough steam to prevent formation of clinkers. Works much better than ordinary bench.			Heats regulated by air inlets and bench damper. Prevent by using steam. Works much better than ordinary retort house.	
95		No	Yes		Sometimes	No
96			At inlet of exhauster ahead of condensers.		At inlet of exhauster.	
97			1½ to 2%		2%	
98			No		No	
99						
100						

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 1

	No. 3	No. 7	No. 8	No. 36		
1	20	24 throughs.	20 throughs.	12 throughs.		
2	Adam Weber Company.	Gas Co.	Riter-Conley.	Riter-Conley.		
3	All	19	10	6		
4	16 in. x 28 in. x 10 ft.	16 in. x 26 in. x 21 ft. 9 in.	16 in. x 26 in. x 13 ft.	16 in. x 26 in. x 21 ft. 9 in. 8's.		
5	New 1902	New 1903	1903 (good)	Not been refilled.		
6		1905-1906	1903 good			
7	24 in. x 52 in. 8.66 sq. ft.	15 sq. ft.	13.75 sq. ft.	20 sq. ft. per furnace; 2 furnaces per bench.		
8	12 ft. 11½ in.	11 ft. 8½ in.		10 ft.		
9	44 ft. 0 in.	58 ft.	76 ft.	88 ft.		
10	6 ft.	6 ft.	6 ft. 6 in.	5 ft. 4 in.		
11	⅓ Fairmont, ⅔ Pool, Youghiogheny.	Youghiogheny	Westmoreland	Westmoreland		
12	5.039	4.86	4.90	4.72		
13	Yes	Yes	No	Yes		
14	No	No	Yes	No		

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 1—*Continued.*

	No. 3	No. 7	No. 8	No. 36		
15						
16	Prop. 75 M. 12 ft. drum 20 M. 10 ft. 55 M.	14 Hinman 1,000,000		9 ft. and 14 ft. 63 M.		
17	Prop. 1 month, drum 1 year.	June '07		July 1906		
18	Accurate	Good		Close		
19	467	4240	2400	4392		
20	15.26	15.3	16.26	15.55		
21	602 gross.	642 gross.				
22	95%	98%	98⅝%	89.7%		
23	80% gas coal. 20% coke.	Hot coke. Gas coal.	Coke	Coke		
24	13500	13000 14000		About 13500		
25	Coal. Coke H_2O - .7 10 V. M. - 35.7 } 80 C. - 58.0 } Ash - 4.5 10 S. - 1.1		Ash - - 8.4 Vol. - - 2.8 C. - - 88.8	Vol. - - 4.83 C. - - 85.74 Ash - - 9.43		
26	Coal Coke 209.2 65.6 274.8	236 lb. coke or 231 coal. Coke estimated.	333.3 Ran a 6 mo. test and found that about 2/9 of coke made was used. Figures based on this.	275 lb. at 30 lb. per bushel.		

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 1—*Continued.*

	No. 3	No. 7	No. 8	No. 36		
27			Large excess of water.	Less than ½ lb. per pound fuel.		
28	No—bar fires once in 24 hours. Clinker once in 3 days.	No	Not with Penn. coal.	No		
29	No	No	No	No		

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 2

	No. 7	No 8	No. 36			
53	According to heat to carbonize in definite time, using Orsat apparatus.	Primary according to furnace fire. Secondary to burn all CO.	Primary to maintain heat. Secondary to burn all producer gas before entering flues.			
54		Average foreman will approximate very closely without analysis.	Above method checked by occasional analysis.			
55	25 to 30	60	60			
56	15 to 20	40	30			
57	30	60	20			
58	7 to 8	4 to 6 Draw air thru retort with steam jet in stand pipe.	6 to 12 hours. Both ends retort open.			
59	No	No	No			
60	One at a time.		Clean one side at a time as quickly as possible, and increase draught on opposite side to disturb temp. of bench as little as possible.			
61	Rapidly as possible. 20 minutes.		Check chimney draught, use plenty of false bars and hurry cleaning.			

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TABLE 2—SO-CALLED FULL-DEPTH—8's PART 2—*Continued.*

	No. 7	No. 8	No. 36			
62	Hot. Keep furnace filled.	Put in as rapidly as possible.	Fill and level in least possible time.			
63	Small charge frequently.		Have had no experience.			
64		Water; at present there does not seem to have been shown any marked saving by the use of waste flue gases.	Water and steam. Simple, cheap and effective.			
65	Machines, combined pusher and charger.	We use combined drawing and charging machine.	By suitable machinery.			
66	Keep water away from bench.	Spray in conveyor trough at end of bench.	Would prefer to quench outside retort house.			
67	Yes	Do these things to a reasonable extent.	Yes			
68			No			
69	6 to 8 hours	Once in 24 hours after clinkering, then every 6 hours.	3 hours.			
70	No	No	No			
71						
72	Medium	About 1800	Medium			
73	2500° F.	1800°	2300 to 2500 F.			

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TABLE 2—SO-CALLED FULL-DEPTH S's—PART 2—(Continued.

	No. 7	No. 8	No. 36			
74			Advantageous			
75			No lamp black nor pitch in mains. Little damage to benches.			
76	No	No	No			
77			Check primary or increase secondary.			
78	No	No	At times, yes.			
79	Trouble remedied by regular heats and regular charging and by keeping pipes clean.		Unable to account for it.			
80	No	Have not considered the matter.	The plan has long been attractive, but have had no experience.			
81						
82						
83	48	24	48			
84		Clinker before—fill after.	Clinker before the draw and draw into furnace			
85	Machine	Machine	Machine			

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 2—*Continued.*

	No. 7	No. 8	No. 36			
86	2 to 3 minutes	4 minutes	3 minutes			
87		Slides set at required opening.	Adjustable dampers.			
88	Ass't Supt.	Managing foreman.	Retort house foreman.			
89	Yes	No	Yes			
90	Thru funnel and pipe to drip pan, overflows to step grates and ash pan.	Water drops in funnel—is led on grate bars—drops in ash pan.	By pipe thru side of furnace.			
91	Yes	No	Yes			
92			For comparison			
93			German Clay			
94		No				
95	Yes	No	Yes			
96	Before exhausters		Before purifiers.			
97	½% to 1%		1%			
98	No		No			
99						
100						

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TABLE 3—SO-CALLED FULL-DEPTH 6's

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
1	8	3	3	32	4 throughs	20 inclined
2	4-Weber 4-Parker-Russell	Laclede F. B. Co.	Parker-Russell	21-Laclede 11-Improved Equip. Co.	Weber	Laclede
3	8	2 all time 2 part of time	3	24.8	3	
4	16 in. x 23 in. x 9 ft.	16 in. x 26 in. x 9 ft.	3—16 in. x 26 in. x 9 ft. 4 in. 6—16 in. x 28 in. x 9 ft. 4 in.	22—15 in. x 26 in. 10—16 in. x 28 in.	16 in. x 28 in. x 20 ft.	15 in. x 23 in. x 18 ft. 15 in. x 26 in. x 18 ft.
5	1903	New 1905 (very fair)	2—1904 1—1906	2—1905, except fur- 2—1906, new. [nace. 10—1906, new. 8—1905, refilled complete. 10—1900, refilled complete.	New	No recuperator renewed.
6			1—1906 (good)	10—1904, refilled complete (fair condition).	New	
7	8.66 sq. ft.	10.7 sq. ft.	9 sq. ft.	10—12.5 sq. ft. 22—8.66 sq. ft.	8¼ sq. ft.	10.69 sq. ft.
8		9 ft. 3 in.	7 ft. 6 in.	12 ft. 4 in.	7 ft. 6 in.	12 ft.
9	40 ft.	52 ft.	45 ft.	50 ft.	No chimney 8 ft. 8 in. to flue opening.	74 ft. 6 in.
10	5 ft.	5½ ft. to 6 ft.	6 ft.	5 ft.	5 ft.	4 to 5 ft.
11	⅓ Fairmont. ⅔ Yough.	Fairmont	Youghiogheny	Berwind Mine-run.	Westmoreland	Pittsburg Mine-run.

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
12	5.039	4.77	4.85	5.00 corr. to 60° only.	About 4.75	4.82
13	Yes	Yes	No	Yes	No	No
14	No	No	Yes	No	Yes	Yes
15						We have meter.
16	10 ft. 55 M. Prop. 75 M. 12 ft. 20 M.	7 M 3 partition drum.				
17	Prop. monthly. Drum yearly.	3 years				
18	Accurate	Fairly accurate.				2% slow.
19	467 lb.	927.5 lb.	1900 lb.	2000 lb.	4800 lb.	3600 lb.
20	15.26	16 not corrected.	14	19	16	About 15
21	602 gross			545		
22	95%		98%	99.3%	94%	
23	80% gas coal, 20% coke.	Fairmont	Coke	Hot Coke	Coke	Coke
24	13500			12000		
25	Coal. Coke H_2O - .7 10 Vol. - 35.7 } 80 C. - 58.0 } Ash - 4.5 10 Sul. - 1.1			Carbon - - 85 Ash - - 15		

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
26	Coal - - 209.2 Coke - - 65.6 274.8	364 lb. Quantity obtained by wt. on platform scales.	290 lb.	264 lb. by occasional test. Coke to coal is 66% by many tests.	330 lb. weighed on occasions.	26% of coke made.
27		Stream of water ½ in. under 20 ft. head; lead through ¾ in. pipe.		None		44-2/10
28	Bar fires every 24 hours. Clinker every 3 days.	8 to 10 days.	No	No	With careful adjustment of steam; no clinkers.	Only at times, due to neglect.
29	No	No	No	Yes	No	No
30				Between bottom retort and recuperator.		
31				2300° F.		
32				17.9 CO_2 by vol. 3.5 O by vol. 0. CO by vol. 79. N by vol.		
33				17.2		
34				42.6		
35				10.5		
36				No water used, no clinkers,		
37				120 lb.		

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
38				50% in cleaning fires.		
39				Carbonized more coal on account of more even temperature, because of no clinkering.		
40				More even temperature.		
41				Less operating repairs than before.		
42				70 lb. water per 100 lb. bench fuel.		
43				No		
44				Lowered		
45				Individual injectors supplied with air at 30 oz. pressure.		
46				By adjustable nozzle in injector and by stack damper.		
47				By temperature of fire.		
48				Each bench individually.		

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
49				Use all waste gases possible without reducing temperature of fire.		
50				Simple, runs months without attention.		
51				All factors were considered. Yield improved.		
52				There is real value in the scheme. Ease of regulation, saving in fuel, longer life of benches, and increased capacity of bench.		
53	By analysis of waste gases. Open primary to make enough gas to heat bench and enough to burn up these gases in bench.	Adjust the damper to give about 18 in. flame in combustion chamber above inlet ports of furnace arch.		Enough primary air to keep up heat. Enough secondary air to burn CO in combustion. Analysis on Orsat machine.	By watching heats and color of flames in waste gas flues.	Chemical analysis.
54	Throw a small lump of coal in hot waste gas flue and watch same through sight hole. Adjust secondary air to just consume gas from lump of coal.			Admit only enough secondary air to keep CO flame out of recuperator. Increase or decrease primary air to change temperature and readjust secondary.		No

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
55	21 days.	6 to 7 weeks.		2 weeks drying, 1 week getting up heat.	28 days.	21 days.
56	14 days.	30		10 days drying, 5 days heating.	14	6 days.
57	30 days.	As soon as any accumulation of carbon occurs.	21	60	18	150 days.
58	12 hours.		8 hours.	5 hours compressed air.		2 to 5 hours.
59	If it needs repairs. Yes.	No		Yes, on account of fuel saving if bench can be down one month or more.	No	No
60	Blow out with compressed air.	Clean one flue at a time with a light scraper of sheet metal on ½ in. pipe.		With compressed air.	Never cleaned flues.	No way but care and judgment.
61	Use false bars and keep a deep bed of fuel above same.	With fire bed kept level and deep there are no hard clinkers or blow holes to admit cold air.		Use false bars. Keep furnace door closed as much as possible.	Usual method	Empty ash pan of water and close dampers.
62	Draw in hot from retort.	Put in hot through a chute.		Often and in small quantities.	Transfer from retort to furnace as quickly as possible.	Hot coke and quickly as possible.
63	Put in front of bench and then push back.	Charge every 2 hours with about 150 lb. Bar on alternate hours unless heat is too sharp.		Often and in small quantities.	Never had experience with coal.	Never used coal.

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 2—*Continued.*

	No. 7	No. 8	No. 36			
74			Advantageous			
75			No lamp black nor pitch in mains. Little damage to benches.			
76	No	No	No			
77			Check primary or increase secondary.			
78	No	No	At times, yes.			
79	Trouble remedied by regular heats and regular charging and by keeping pipes clean.		Unable to account for it.			
80	No	Have not considered the matter.	The plan has long been attractive, but have had no experience.			
81						
82						
83	48	24	48			
84		Clinker before—fill after.	Clinker before the draw and draw into furnace.			
85	Machine	Machine	Machine			

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TABLE 2—SO-CALLED FULL-DEPTH 8's—PART 2—*Continued.*

	No. 7	No. 8	No. 36			
86	2 to 3 minutes	4 minutes	3 minutes			
87		Slides set at required opening.	Adjustable dampers.			
88	Ass't Supt.	Managing foreman.	Retort house foreman.			
89	Yes	No	Yes			
90	Thru funnel and pipe to drip pan, overflows to step grates and ash pan.	Water drops in funnel—is led on grate bars—drops in ash pan.	By pipe thru side of furnace.			
91	Yes	No	Yes			
92			For comparison			
93			German Clay			
94		No				
95	Yes	No	Yes			
96	Before exhausters		Before purifiers.			
97	½% to 1%		1%			
98	No		No			
99						
100						

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TABLE 8—SO-CALLED FULL-DEPTH 6's

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
1	8	3	3	32	4 throughs	20 inclined
2	4-Weber 4-Parker-Russell	Laclede F. B. Co.	Parker-Russell	21-Laclede 11-Improved Equip. Co.	Weber	Laclede
3	8	2 all time 2 part of time	3	24.8	3	
4	16 in. x 23 in. x 9 ft.	16 in. x 26 in. x 9 ft.	3—16 in. x 26 in. x 9 ft. 4 in. 6—16 in. x 28 in. x 9 ft. 4 in.	22—15 in. x 26 in. 10—16 in. x 28 in.	16 in. x 28 in. x 20 ft.	15 in. x 23 in. x 18 ft. 15 in. x 26 in. x 18 ft.
5	1903	New 1905 (very fair)	2—1904 1—1906	2—1905, except fur-nace. 2—1905, new. 10—1906, new. 8—1905, refilled complete. 10—1900, refilled complete.	New	No recuperator renewed.
6			1—1906 (good)	10—1904, refilled complete (fair condition).	New	
7	8.66 sq. ft.	10.7 sq. ft.	9 sq. ft.	10—12.5 sq. ft. 22—8.66 sq. ft.	8¼ sq. ft.	10.69 sq. ft.
8		9 ft. 3 in.	7 ft. 6 in.	12 ft. 4 in.	7 ft. 6 in.	12 ft.
9	40 ft.	52 ft.	45 ft.	50 ft.	No chimney 8 ft. 8 in. to flue opening.	74 ft. 6 in.
10	5 ft.	5½ ft. to 6 ft.	6 ft.	5 ft.	5 ft.	4 to 5 ft.
11	⅓ Fairmont. ⅔ Yough.	Fairmont	Youghiogheny	Berwind Mine-run.	Westmoreland	Pittsburg Mine-run.

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 8	No. 10	No. 11	No. 34	No. 39	No. 41
12	5.039	4.77	4.85	5.00 corr. to 60° only.	About 4.75	4.82
13	Yes	Yes	No	Yes	No	No
14	No	No	Yes	No	Yes	Yes
15						We have meter.
16	10 ft. 55 M. Prop. 75 M. 12 ft. 20 M.	7 M 3 partition drum.				
17	Prop. monthly. Drum yearly.	3 years				
18	Accurate	Fairly accurate.				2% slow.
19	467 lb.	927.5 lb.	1900 lb.	2000 lb.	4800 lb.	3600 lb.
20	15.26	16 not corrected.	14	19	16	About 15
21	602 gross			545		
22	95%		98%	99.3%	94%	
23	80% gas coal, 20% coke.	Fairmont	Coke	Hot Coke	Coke	Coke
24	13500			12000		
25	Coal. Coke H_2O - .7 10 Vol. - 35.7 } 80 C. - 58.0 } Ash - 4.5 10 Sul. - 1.1			Carbon - - 85 Ash - - 15		

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
26	Coal - - 209.2 Coke - - 65.6 274.8	364 lb. Quantity obtained by wt. on platform scales.	290 lb.	264 lb. by occasional test. Coke to coal is 66% by many tests.	330 lb. weighed on occasions.	26% of coke made.
27		Stream of water ½ in. under 20 ft. head; lead through ¾ in. pipe.		None		44-2/10
28	Bar fires every 24 hours. Clinker every 3 days.	8 to 10 days.	No	No	With careful adjustment of steam; no clinkers.	Only at times, due to neglect.
29	No	No	No	Yes	No	No
30				Between bottom retort and recuperator.		
31				2300° F.		
32				17.9 CO_2 by vol. 3.5 O by vol. 0. CO by vol. 79. N by vol.		
33				17.2		
34				42.6		
35				10.5		
36				No water used, no clinkers.		
37				120 lb.		

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
38				50% in cleaning fires.		
39				Carbonized more coal on account of more even temperature, because of no clinkering.		
40				More even temperature.		
41				Less operating repairs than before.		
42				70 lb. water per 100 lb. bench fuel.		
43				No		
44				Lowered		
45				Individual injectors supplied with air at 30 oz. pressure.		
46				By adjustable nozzle in injector and by stack damper.		
47				By temperature of fire.		
48				Each bench individually.		

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
49				Use all waste gases possible without reducing temperature of fire.		
50				Simple, runs months without attention.		
51				All factors were considered. Yield improved.		
52				There is real value in the scheme. Ease of regulation, saving in fuel, longer life of benches, and increased capacity of bench.		
53	By analysis of waste gases. Open primary to make enough gas to heat bench and enough to burn up these gases in bench.	Adjust the damper to give about 18 in. flame in combustion chamber above inlet ports of furnace arch.		Enough primary air to keep up heat. Enough secondary air to burn CO in combustion. Analysis on Orsat machine.	By watching heats and color of flames in waste gas flues.	Chemical analysis.
54	Throw a small lump of coal in hot waste gas flue and watch same through sight hole. Adjust secondary air to just consume gas from lump of coal.			Admit only enough secondary air to keep CO flame out of recuperator. Increase or decrease primary air to change temperature and readjust secondary.		No

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
55	21 days.	6 to 7 weeks.		2 weeks drying, 1 week getting up heat.	28 days.	21 days.
56	14 days.	30		10 days drying, 5 days heating.	14	6 days.
57	30 days.	As soon as any accumulation of carbon occurs.	21	60	18	150 days.
58	12 hours.		8 hours.	5 hours compressed air.		2 to 5 hours.
59	If it needs repairs. Yes.	No		Yes, on account of fuel saving if bench can be down one month or more.	No	No
60	Blow out with compressed air.	Clean one flue at a time with a light scraper of sheet metal on ½ in. pipe.		With compressed air.	Never cleaned flues.	No way but care and judgment.
61	Use false bars and keep a deep bed of fuel above same.	With fire bed kept level and deep there are no hard clinkers or blow holes to admit cold air.		Use false bars. Keep furnace door closed as much as possible.	Usual method	Empty ash pan of water and close dampers.
62	Draw in hot from retort.	Put in hot through a chute.		Often and in small quantities.	Transfer from retort to furnace as quickly as possible.	Hot coke and quickly as possible.
63	Put in front of bench and then push back.	Charge every 2 hours with about 150 lb. Bar on alternate hours unless heat is too sharp.		Often and in small quantities.	Never had experience with coal.	Never used coal.

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TABLE 3—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
64	Exhaust steam and water.	We find water enough.	Use water and steam	Flue gas, no clinkers, fuel economy. Ease of regulation, greater capacity, long life of bench.	Have used only water and steam.	
65		Machine.		Charge and draw by hand.	As quickly as possible, preferably with machine.	
66	Chutes or platform in front of bench.	Quench on floor in front of benches up to 5's. Steel shield to keep water off of bench.		In chutes.	In conveyor.	Prefer to quench away from bench.
67	No. But to improve appearance of house and for general effect on men.	Not for life of bench but for appearance.	Yes	Keep mouth piece clean for appearance. Leave dust as insulator.		Yes, if practical.
68	No	Yes, if we had one capable.	Yes	Yes, for more careful adjustment than can be made by eye.	Have no chemist.	If experienced, yes.
69	2 hours	2 hours.	3 hours.	6 hours.	4 hours.	5 hours.
70	No	No	No	Not necessary with economizer.	No	No
71				Same as above.		
72	Medium	Bright cherry	High	1500° C.	Medium	Medium
73	1250° to 1350° C.		1800° in upper plug.	1500 C.		

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
74	We think so.	Do not know, but our heat does not appear hurtful.	Have that heat in order to carbonize 400 lb. in 4 hours.	Advantageous	We believe it to be the best.	Operate at what seems best every-day working temperature.
75	Long life, good tar and fair ammonia yield.		Causes some lamp black and has some tendency to pitch.	Better yield.		
76	No	No	No	No	No	No
77			If bench is hot enough, shut stack damper and shut off primary air till we have proper vacuum at sight plug in combustion chamber. If bench is cold, open secondary air.			
78	No	Seldom clean except when scurfing retorts.	Some	No	No	Not much more in summer than winter.
79		Attribute freedom to getting charges well back, and not running heat too high. Stand pipe has 5 in. ring run up at each charge.	High heats and retorts charged unevenly.			Largely radiation.
80		If large enough it would pay on uniformity and maintenance rather than on fuel economy or first cost. Not pay on 15 benches.				

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
81		According to careful investigation before building this stack.				
82						
83	72 hours. Bar and hook out every 24 hours.	8 to 10 days.	24 hours.	Do not clinker. Clean fires once in 12 hours.	Slice fire every 24 hours. Clean every 48 hours.	24 hours.
84	Before and after.	Keep each on its own schedule, fire every 2 hours, draw every 4 to 6 hours. Clinker when convenient, take out ash once a day.	After	Clean before draw, fill during draw.	Clinker before, charge after.	24 hours before draw.
85	Some by machine and some by hand.	Hand	Hand	Hand	Machine	Stokers
86	3 minutes by machine, 8 minutes by hand.	8 minutes.	10 minutes.	Charge and draw three at a time, 10 minutes.	20 minutes.	6 to 9
87	By port openings.	Shutter with thumb screw		Adjustable dampers and nozzle in injector.	Sliding dampers.	Regulate to burn fixed charge with minimum fuel.
88	Foreman only.	Foreman only.		Retort house foreman.	Sup't.	Sup't.
89	Yes	Yes. Do not know.	Yes. No record.	Yes 1200 C.	Yes. Don't know	No
90	Water on water table above clinker door. Steam by jet under middle of grate bars.	Drips into an open funnel leading by pipe into ash pan.	Drip plates.		Fill ash pan with water, steam according to judgment.	Step grates.

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TABLE 8—SO-CALLED FULL-DEPTH 6's—*Continued.*

	No. 3	No. 10	No. 11	No. 34	No. 39	No. 41
91	No	Only as to bench fuel.	No	No	Yes, in a general way.	Not very carefully.
92		All important things are on schedule.			For record.	With small number of benches, Sup't. can keep in touch.
93		Not able to say.		St. Louis material.		Have found no domestic very reliable.
94						Inclines; require closer attention than horizontals in order to have good discharge.
95	Yes	No	No	Yes	No	Yes
96	Inlet of exhauster.			Continuously at exhauster.		Exhauster.
97	1.5%			1.5%		
98	No			No		No
99						
100						

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TABLE 4—SO-CALLED THREE-QUARTER-DEPTH 6's

	No. 29	No. 30	No. 38			
1	4	2	6			
2	Laclede F. B. Mfg. Co.	Bredel	Parker-Russell			
3	2	2	6			
4		16 x 28 x 9 ft. 7½ in.	16 x 28 x 10 ft.			
5	In use 2 years (good).	3 years ago (bad).	July-1904 (fair).			
6	2 years. Condition good.	Not been filled.				
7		10 sq. ft.	9 sq. ft.			
8						
9			42 ft.			
10	About 3 ft.	3 ft.	4 ft.			
11	Pittsburg Coal Co.	Yough.	Berwind			
12	5 ft. meter run.	5 cu. ft.	5 cu. ft. corr. to 60° F. only.			
13	Make only coal gas.	No	No			
14		Sometimes	Yes			
15	We have station meter.	We have station meter.	We have station meter.			
16						

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TABLE 4—SO-CALLED THREE-QUARTER-DEPTH 6's—*Continued.*

	No. 29	No. 30	No. 38			
17	1903 (new)	3 years ago.				
18	Correct	Correct	Correct			
19	1350 to 1450	400 lb. per retort to 300 lb. per retort.	1700 lb.			
20	18	17	16			
21						
22	97 to 98%					
23	Mine run Ill. coal.	Coke	Coke			
24			12000			
25						
26	1400 lb. per 24 hours.	30%	350 lb.			
27	Very small jet of water and some steam.					
28	No	No	No			
53						
54						
55		14 to 21	21			
56			12			
57	Every 7 days.	When needed.	When needed.			

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TABLE 4—SO-CALLED THREE-QUARTER-DEPTH 6's—*Continued.*

	No. 29	No. 30	No. 38			
58	6 hours air blast.	4 hours.	4 to 6 hours air or steam.			
59	No	No	No			
60			By blowing with steam.			
61	With clinker bars and care in doing work.		Careful workmen. Use stack damper. Both should be done as quickly as possible.			
62			Have fire in good condition. Put coke in hot and quickly.			
63	Fire in regular way 500 lb. to charge.					
64	Water and steam to rot clinker.		Flue gases greater efficiency all around. Perfect control of heats. Easier on benches.			
65			Uniform depth of coal. Care in handling rake. Quick work.			
66			Would quench in chutes.			
67			Yes			

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TABLE 4—SO-CALLED THREE-QUARTER-DEPTH 6's—*Continued.*

	No. 29	No. 30	No. 38			
68			Yes			
69		6 hours.	6 hours.			
70		No	No			
71						
72	Medium	High	Medium			
73			2000 F.			
74	Disadvantageous to run too high heats and try to get too much gas from coal. Kills C. P. and makes trouble.	Yes	Advantageous			
75			Better gas, more tar, less napthalene; better results.			
76	No	No	No			
77			Usually more secondary air.			
78	Burn them out when scurfing retorts.	Sometimes	No			
79	Too much coal or too high heats.	Not cleaned properly when they are cleaned.	No			
80			No			
81						

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TABLE 4—SO-CALLED THREE-QUARTER-DEPTH 6's—*Continued.*

	No. 29	No. 30	No. 38			
82			No great saving, though producer may have 80% efficiency.			
83	Every day	Every 3 days	Every 4 days			
84	After retort is charged, but before fire pot is filled.	Before	Clinker before, fill after.			
85	Hand	Hand	Hand			
86	Very short time	Short as possible	10 minutes			
87		Shutter	Test flue gas			
88	Sup't.	Foreman	Foreman			
89		No	Yes			
90		Pipe	Dripping			
91	Yes	No	Yes			
92			For comparison			
93						
94						
95	No					
96						
97						
98						
99						
100						

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Table 5—So-Called Half-Depth 6's—Part 1

	No. 8	No. 11	No. 12	No. 13		
1	2	3	8—rear clinkered	12		
2	Weber	Laclede-Mitchell	Parker-Russell			
3	1	2	6	8		
4	14 in. x 24 in. x 9 ft. 0 in.	16 in. x 28 in. x 9 ft. 0 in.	15 in. x 26 in. x 9 ft. 6 in.	14½ in. x 25 in.		
5				6—Sept. 9, '06 (poor).		
6		1905 (good).				
7	6 sq. ft.	7 sq. ft.	6.75 sq. ft.	6 sq. ft.		
8	3 ft. 9 in.		5 ft. 0 in.			
9	40 ft. 0 in.	35 ft. 0 in.	30 ft. 0 in.	40 ft. 0 in.		
10		3 ft. 6 in.	3 ft. 0 in.	3 ft. 0 in.		
11	⅓ Fairmont. ⅔ Yough.	Yough.		Westmoreland		
12	5.039	4.85		4.69 cor. for temp. only.		
13	Yes	No		Yes		
14	No	Yes	Yes	No		
15			Have one meter.			
16	Prop. 75 M. 12 ft. drum 20 M. 10 ft. drum 55 M.		6 ft. old style	10 ft. Hinman		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 8	No. 11	No. 12	No. 13		
17	Prop. every month; drum every year.		18 months ago.	8/31/'06.		
18	Correct		10% slow	Correct		
19	467 lb.	1900 lb.		318 lb.		
20	15.26	14.00	17.00	18.00		
21	602 gross.					
22	95%	98%	97½%			
23	80% gas coal, 20% coke.	Coke	Coke and Illinois coal.	Coke		
24	13500 B. T. U.					
25	Coal. Coke H_2O - 0.7 10 V. M. - 35.7 } 80 F. C. - 58.0 } Ash - 4.5 10 Sulp. - 1.1					
26	Coal - 209-2/10 lb. Coke - 65-6/10 lb.	290 lb. figured 60% by weight of coal carbonized.		318 lb. estimated.		
27						
28	No. Bar fires once in 24 hours. Clinker about once in three days.	No	When using water we did, but since have added steam, which seems to make the clinker more easy to handle.	Yes		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 3	No. 11	No. 12	No. 13		
53	By analysis of waste gases. Open primary to make enough gas to heat bench and enough to burn up these gases in bench.		Set primary slides to maintain proper heats in bench and not produce excessive amount of clinker. Set secondary slides so blue flame will not be visible in the second flue from the top.	By noting combustion of gases above fire.		
54	Throw a small lump of coal in hot waste gas flue and watch same through sight hole. Adjust secondary air to just consume gas from lump of coal.					
55	21 days.		30 days.	8 days.		
56	14 days.		15 days.	5 days.		
57	30 days.	21 days.	30 days.	21 days.		
58	12 hours. Jet blower using compressed air and steam.	About 8 hours.	From 8 to 12 hours by using a steam jet in stand pipe.			
59	If it needs repairs—yes.		No	No		
60	Blow out with compressed air.		By reducing the draft and scraping the flues.	Close stack damper.		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 8	No. 11	No. 12	No. 13		
61	Use false bars and keep a deep bed of fuel above same.		By shoving in dampers in recuperator to prevent inrush of cold air.			
62	Draw in hot from retort.		By putting it in hot and keeping it full.	Put hot coke in as quickly as possible.		
63	Put in front of bench and then put back after coal has partially coked.		By firing every hour and a half and keeping the furnace filled.	Smaller quantity than coke.		
64	Exhaust steam and water.	Water and steam.	We use steam.	Water cheaper and more uniform.		
65			By drawing and charging two at a time in each bench.			
66	Chutes or platform in front of bench.		Quench in conveyors outside the building.	Quench away from bench if mechanical means is at hand to remove coke.		
67	No—but to improve appearance of house and general effect on men.	Yes	Yes	No		
68	No	Yes	Yes, if we had one.	Yes		
69	Every 2 hours.	Every 3 hours.	About every 3 hours.	Every 2 hours.		
70	No—bench will not lose heat to any extent.	No	Have dampers in top flue of bench.			

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 3	No. 11	No. 12	No. 13		
71			No			
72	Medium	High heat.	Medium	Medium		
73	1250° C. to 1350° C.	1800°				
74	We think so.	Use this heat to carbonize 400 lbs. coal in four hours.		Not on account of bench but for quality of product.		
75	Long life, good tar and fair ammonia yield.	Causes some lamp black and has tendency to pitch.				
76	No	No	No	No		
77		If bench is hot enough, close stack damper, shut primary air to get proper vacuum in combustion chamber. If bench is cold open secondary air.	Increase the secondary air.			
78	No	Some	No	No		
79		High heats and uneven charging of retorts.	Lack of care and poor tools.			
80						
81						
82						

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 3	No. 11	No. 12	No. 13		
83	Every 72 hours. Bar and hook out every 24 hours.	Every 24 hours.	Every 24 hours.	Every 24 hours.		
84	Before clinkering and again right after clinkering.	After	Fill furnace after clinkering.	Before draw.		
85	Some by hand and some by machine.	Hand	Hand	Hand		
86	By machine—3 minutes. By hand—8 minutes.	10 minutes.	15 minutes.	20 minutes.		
87	By port openings.		With air box slide.	Ordinary slide.		
88	Foreman		Retort house foreman.	Foreman		
89	Yes	Yes. No record.	Heat it with waste gases, do not know to what degree.			
90	Water on water table above clinker door and steam under middle of grate bars.	With drip plates.	Water onto step grate. Steam under the grate.	By pipes.		
91	No	No	No	No		
92						
93						
94						

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 1—*Continued.*

	No. 3	No. 11	No. 12	No. 13		
95	Yes	No		Yes		
96	At inlet of exhauster.			Outlet of exhauster.		
97	1½%			2%		
98	No			No		
99						
100						

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2

	No. 14	No. 15	No. 16	No. 17	No. 18	
1	10	7	6	5—Rear clinkering	5	
2		3—Parker-Russell. 4—J. Gardner.	Weber	Parker-Russell.	Mo. F. B. Co. Parker-Russell.	
3	5	4	5	5½	3	
4	28 in. x 16 in. x 9 ft. 3 in.	15 in. x 26 in. x 9 ft. 3 in.	14 in. x 25 in. x 9 ft. 0 in.	16 in. x 26 in. x 9 ft. 0 in.	15 in. x 26 in. x 9 ft. 0 in.	
5	3—1905 2—1906 (all good)	2—1906 1—1905 1—1904 (fair)	4—1905 2—1906	1902 (new)	When retorts have made 7000000 cubic feet.	
6				3—1905 2—1906 1—1907 (good)	Good to bad.	
7	7½ sq. ft.		5 sq. ft.	6½ sq. ft.	7½ sq. ft.	
8	4 ft. 9 in.		4 ft. 0 in.	4 ft. 4 in.	3 ft 0 in.	
9	80 ft. 0 in.		66 ft. 0 in.	50 ft. 0 in.	20 ft. 0 in.	
10	3 ft. 0 in.		2 ft. 9 in.	3 ft. 0 in.	2 ft. 6 in.	
11	Westmoreland, ¾ in. lump.	¾ Yough.	16 Westmoreland.	¾ Yough.	Fourth pool lump, 70%; mine run, 20%; slack, 10%. (All Pittsburg.)	
12	4.75 not cor.	4.718	4.9 not cor.	4.65	5.2 not cor. for barometer.	
13	Yes	Yes	Yes	Yes	Yes	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18
14	Yes, but W. G. is metered separately.	No	No. W. G.	No	No
15	Have two meters.		We have one.	We have one.	
16	7 ft. 10 M. to 15 M. per hour.		6 ft. old style, 9,600 cu. ft. per hour.	6 ft. 15 M. per hour.	
17	New 3 years ago.		1905	New 1903	3 or 4 years ago.
18	Correct		Good	Correct	Approx. cor.
19	290 lb.	2183.7 lb.	1200 lb.	1650 lb.	1635 lb.
20	17.5		17.8		16
21					
22	50%	87½%	91%		95%
23	Coke	Yough. lump; one bench on coke.	Hot coke.	Gas coke Gas coal	Coke
24					
25		Water - - 1.26 V. M. - - 34.78 F. C. - - 59.22 Ash - - 6.24			
26	400 lb., estimated from number of charges and weight per charge.	372.48 lb.	488 lb.—65% of weight of charge.	400 lb.—coal weighed; coke estimated.	392 lb.—28% of coke made.

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18	
27			2 5-10 lb. water per 100 lb. fuel. ½ in. valve cracked 8 hours out of 24.		No water.	
28	No	No	Very seldom—soften with steam 8 hours in advance.	No	No	
53	By slide spy boxes.	Admit excess of primary air until the bench has reached the proper temp. Open secondary air until full combustion is obtained before waste flues. Reduce primary as much as possible to complete combustion by manipulating secondary.	By observation in top of fire and top of furnace.	Regulate damper so the gases in the flue show perfect combustion.	By observing no combustion in last flue. So regulate secondary, open or close both according to exigency.	
54	If retort house foreman keeps record of coke consumption every day he can regulate heat without chemical analysis. By doing this he can tell when heats are up to standard.	By watching waste gases carefully—also condition of fires and the amount of clinker.	Chemical analysis best. If it cannot be analyzed, then regulate primary and stack by flame direction and secondary by color in top of furnace	None except as stated in answer to above question.	As stated in above question.	
55	14 days.	20 to 30 days.	30 days.	10 to 15 days.	7 days.	
56	5 to 7 days.	10 to 15 days.	10 days.	6 to 10 days.	2 days.	
57	60 days.	10 days.	90 days.	90 days.		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18	
58	24 hours.	From 2 to 4 hours, steam jet and carbon pipe.	Open the door 24 to 36 hours.	Four hours. Steam jet blast preferred.		
59	No	No	Yes	No — except sufficient to thoroughly clean furnace and flues.	No	
60	If bench is in operation close dampers temporarily and open producer door.	With a steel brush on horizontal—air blast on vertical.	Do it every day before soot, cinders and ashes are baked on.	Scrape as far as possible. Use steam when scraper fails to reach.	Bench flues large enough so as not to require cleaning.	
61	By careful clinkering.	Turn on steam 4 minutes before clinkering — use auxiliary bars and fill furnace immediately after clinkering.	Use sharp bar and care.	By use of false grate bars.	Shut dampers.	
62	Put coke in hot as quickly as possible at regular intervals of about 2 hours.	Hot as possible every 2 hours.	Feed from hopper and spread evenly.	Use hot coke.	Draw from retort to furnace.	
63	Never use coal for this purpose.	Every 2 hours, break fire each hour—select lump coal.		Feed coal in front of furnace until it cokes, then shove back and feed coke again.		
64	Water easy to regulate and sufficient to prevent clinkering, using Westmoreland coal.	Water and steam to reduce clinker.	Use water in ash pan and steam under grate. No experience with flue gases.	Have used only water and steam.	Steam; get better results.	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18
65	By good hard labor.	Speed, regularity and skill. Avoid friction between shifts.	By machine if works permit charge with scoops. Saves retorts. We charge by hand and save time. Draw with hook and use all possible care.	By keeping mouthpieces open as short time as possible.	Have but one way—man and rake.
66	If we had in conveyors—otherwise in quenching tank outside, in close proximity to the retort house.	No. Quenched in wagons below floor.	Quench out of doors, get rid of steam in house.	Not if it could be avoided.	Quench in wagon and again when dumped.
67	Yes, to prolong their life and keep them clean. Good results seldom obtained in dirty retort house.	Yes	Yes	Yes	No. Dust is a nonconductor. Keep tar off mouthpieces for appearance sake.
68	Only if chemist were skilled as a carbonizer as well as in chemistry of gases.	Yes, if we had one.	Do not know. Have no chemist.	No	A chemist with business sense is all right, but ordinarily, no.
69	2 hours.	2 hours.	3 hours.	2 hours.	2 hours.
70	No, except using false bars when cleaning and clinkering.	Fire immediately after clinkering; have no trouble from cooling.	No	Yes, by use of false grate bars.	Put in damper.
71				No	Hand
72	White heat in combustion chamber about 1500° C.	High	A little above medium.	Medium	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18	
73	Retorts 1800° to 2000° F.		2900° F.			
74	Advantageous.	Consider it advantageous.	Advantageous.	We think advantageous.	High heats are best.	
75	Gives high yield of 16 C. P. gas, coals well carbonized, coke better. Reduces carbonizing wages and gives a greater yield of salable coke.	High production for retort and for stoker.	Good yield, good ammonia, moderate tar and no excess of carbon in retort. Little trouble from naphthalene or sulphur compounds.	Life of retorts.		
76	No	No	No	No	No	
77	Readjust dampers, secondary and primary air inlets. If chimney too small, hard to prevent.	Increase secondary air.			Never had it except when retort leaks.	
78	Not much.	Not excessive with good coal.	No	Comparatively little.	Not much.	
79	Excessive hydraulic seals and high heats.	Fine dusty coal.	Excessive heats.	Heavy seal or leak at mouthpiece.	Not much.	
80	Yes		No experience.	Yes		
81	Economy in fuel and labor, uniformity of composition of the gases, easy regulation and operation.			More even heats and life of retorts.		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18	
82	Only in the case of works too small.					
83	24 hours.	8 to 10 days.	24 hours.	24 hours.	Four times a month, sometimes once in 10 days.	
84	Before draw.	Before draw.	At stated times without reference to draw.	After draw.	Before draw.	
85	Hand, but had experience with machinery.	Hand	Hand	Hand	Hand	
86	6 minutes.	10 minutes.	3 to 4 minutes.	10 minutes.	5 to 8 minutes.	
87	Slide boxes.		By damper to show CO in top of furnace, then admit secondary air to burn CO to CO_2.	Dampers		
88	Retort house foreman.	Foreman	General foreman.	Foreman	Retort house foreman.	
89	Yes. About 150°.	Yes. No record.	Yes. Do not know.	Yes	Yes. Do not know. Red hot.	
90	By ½ in. pipe passing through brickwork above clinkering door on to water trays, thence to water pans.	Water on drip pans. Steam blown into water in ash pan.	Water by hose in each pit every morning. Steam by pipe under front of grate before clinkering.	Water drips over cast iron plates. Steam in ashpit.	Steam ¾ in. pipe.	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 2—*Continued.*

	No. 14	No. 15	No. 16	No. 17	No. 18
91	Yes	No	Yes	Record of hours in use and repairs made.	No
92	To keep works foreman and manager posted as to regularity of heats, coal used, coke fuel consumed, time fires cleaned and coke salable.	Extra cost of weighing coal separately.	To get fuel used, time of firing and time each retort is charged and drawn.		
93	Silica firebricks and silica clay for transverse walls above level of producer arch. Everything else good, sound firebrick.		Materials in benches with best records. Do not know what the clay was.		
94					
95	Not here, but once introduced it at purifier inlet.	Yes	Yes	No	Yes
96		Exhauster	Outlet of exhauster.		Continuously
97	2%	2%	6/10%		3%
98	No	No	No		No
99					
100					

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 3

	No. 19	No. 20	No. 21	No. 22	No. 23	
1	5	5	4	3	5	
2	Parker-Russell.	Parker-Russell.	Parker-Russell.	2 -Parker-Russell. 1—Gas Bench Const. Company.	Parker-Russell.	
3	3½	5		2	4	
4	15 in. x 26 in. x 10 ft. and 16 in. x 28 in. x 10 ft.	16 in. x 28 in. x 9 ft 0 in.	16 in. x 28 in. x 8 ft.	16 in. x 26 in. x 9 ft. 3 in.	16 in. x 28 in. x 10 ft.	
5	1—5/10/'05 2—6/25/'07 3—6/25/'07 4 - 9/20/'06 5 9/20/'06	New 9/2/'03	Two years (fair).	1 — Parker - Russell, 1904. 1 — Parker - Russell, 1905. 1 — Gas B., 1907. (fairly good).		
6				1—1905. 1—1907. (fairly good)	2—1906. 2—1905. (good)	
7	6.75 sq. ft.	6 sq. ft.	6¾ sq. ft.		7.85 sq. ft.	
8	3 ft. 0 in.	4 ft. 11 in.	4 ft. 4 in.		4 ft. 4 in.	
9	33 ft. 0 in.	30 ft. 3 in.	31 ft. 0 in.		28 ft. 4 in.	
10	2 ft. 6 in.	2 ft. 9 in.	1 ft. 8 in.		2 ft. 6 in. to 2 ft. 10 in.	
11	Farmington	Yough. ¾	Empire No. 2 lump.	West Va. ¾ lump.	West Va.	
12	4.70 not cor. for barometer.	5.00	4.2 not cor. to barometer.	4.83	4.60	
13		No. We make very little water gas.	Yes	Yes	Yes	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 3—*Continued.*

	No. 19	No. 20	No. 21	No. 22	No. 23	
14		Yes	No	No	No	
15						
16	7 ft. Hinman drum.	7 ft. Hinman drum, 35 M. per hour.	4 ft. 6 in., 7 M. per hour.		2-6 ft., 9 M. per hour.	
17	April 1904	February 1907	1889		4 years ago.	
18	Registration had not changed for 2 years.	1% error	5% slow		Correct	
19	1813 lb.	2178 lb.	1615 lb.	1500 lb.		
20	16.84	17.5	16	16	17	
21						
22	85%	99%	94%	89%	80%	
23	Coke	Coke and coal.	Coke	Lump coke.	Hot coke.	
24						
25						
26	360 lb., coke to benches is estimated from charge of coal in retort.	340 lb.	60% of coal carbonized; coke 35% of this, as filled under retorts.	420 lb.	366 lb., obtained by proportion.	
27						
28	No	No	No	No	No	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 8—*Continued.*

	No. 19	No. 20	No. 21	No. 22	No. 23	
53	By trial using both stack damper and inlets until proper heat is obtained.	By temperature of flues and heat on bench.	By observation and experimenting.	By closely observing fire and regulating dampers accordingly.		
54	Our retort house foreman does this with occasional suggestions.			Not accurately.		
55	10 days	14 to 21 days.	14 days	5 to 14 days.		
56	If next to a hot bench 4 days; otherwise a week.	7 days	8 to 10 days.	From 3 to 10 days.		
57	Go according to conditions.	70 days	30 days	Whenever required.		
58	From 2 to 8 hours by air drawn by steam jet.	4 to 8 hours using steam air syphon.	6 hours with steam.	24 hours with air only.		
59	Never	No	Would not shut down for less than 60 days.	No, never		
60	Close stack dampers, clean flue openings one at a time.	We use hoe with iron handle.		By using a scraper.		
61	Same principle as in above answer.	Use secondary grate and keep clinker bars sharp.		By using false bars to hold fire.		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 8—*Continued.*

	No. 19	No. 20	No. 21	No. 22	No. 23	
62	We take no extra precautions except at clinkering time, when hot coke from retorts is used.	When possible throw in with scoop and let lie where it falls.	Charge with hot coke.	Hot, right from retort.		
63		Same as in above answer.				
64	We use water. Mainly because we think it works well and have never tried anything else.	We use water.	Water	We use water.		
65	Leave them open as short a time as possible.	We draw by hand.		Draw and charge as rapidly as possible with rake.		
66			In front of bench.	We quench our coke on floor and use sheet iron in front of bench to protect brick.		
67		Yes	Yes	We keep tar off of mouthpieces, but do not disturb top of stacks.		
68				Yes, if we had a chemist.		
69		At 2 hour intervals.	Every 2¼ hours.	Every 3 hours.		
70		No	No	No. Only by doing the work as rapidly as possible.		
71				None		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 8—*Continued.*

	No. 19	No. 20	No. 21	No. 22	No. 23	
72		High	High	Medium		
73						
74		Advantageous	Yes	We believe it prolongs life of bench.		
75		Gives high yield and high make of bench but is detrimental to furnace.	Better yield. More naphthalene.			
76		No	No	No		
77		Give bench more secondary air.	Patch retorts. Increase secondary air. Decrease primary air.			
78		No	Have our share.	Not with the medium heat we carry.		
79			High heats.	Too high heat and neglect in cleaning standpipe when opened.		
80			No			
81						
82						
83		Once in 4 days.	Every 12 hours.	Once every week.		
84	After	After	After	Just before.	Before	

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 8—*Continued.*

	No. 19	No. 20	No. 21	No. 22	No. 23
85	Hand	Hand	Hand	Hand	Hand
86	12 minutes.	12 minutes.	15 minutes.	8 minutes.	4 minutes.
87	By size of inlet.	By iron shutters in rear of bench.		By natural circulation of air governed by use of damper door.	Slide valves.
88	Foreman	Superintendent	Foreman	Retort house foreman.	Foreman
89	Heated but not measured.	Yes	Yes, but degrees not known.	Yes, but do not know temperature.	Yes
90	Use water dropped onto plate at front.	Water runs down over water tray and steam is introduced under grates.	Water drips over cast iron plates.	Over the ash pan door.	Water pipes leading through front wall of bench.
91	No	Yes	No	No	No
92		To determine the life.			
93					
94					
95	No	No	Yes	No	No
96			Before exhausters.		
97			1½%		
98			No		
99					
100					

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Table 5—So-Called Half-Depth 6's—Part 4

	No. 35		No. 42			
1	4		20—Parker-Russell.			
2	Laclede, 2 Parker-Russell, 1 Gas Bench, 1		Gas Company.			
3	2		18			
4	Laclede and Parker-Russell, 16 in. x 28 in. x 9 ft. 2 in. Gas Bench, 15 in. x 26 in. x 9 ft. 2 in.					
5	Refilled 12 and 18 months ago.		20 benches refilled 2 years ago.			
6						
7	5.25 sq. ft.		7.5 sq. ft.			
8	3 ft. 6 in.		4 ft. 4 in.			
9	28 ft. 0 in.		24 ft. 0 in.			
10	2 ft. 8 in.		3 ft. 0 in.			
11	Yough.		Pennsylvania, Pittsburg & Westmoreland.			
12	5.03		4.75			
13	Coal gas only is made.		Yes			

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42			
14			No.			
15	We have a sta. meter.		We have 5.			
16						
17	Oct., 1906, and Nov., 1906.					
18						
19	1920 lb. 6 hour charges of 480 lb. each.		1790 lb.			
20			15.45			
21			618			
22	91 6/10%		97%			
23	Coke for 6 months. Coal for 6 months.		Hot coke.			
24	Coal—11,000 B. T. U.					
25						
26	22% of coke carbonized.		Bench fuel is not weighed.			
27						
28	No		No. Sufficient steam is introduced well back to just keep the clinker soft.			

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42			
53	Primary open just enough to keep the fuel bed at a high cherry color and a faint show of heat in lowest recupera tor flue.		By temperature of retorts.			
54	Positively, no. He may be introducing too much air, which is doubtless oftener the case than that of not enough be ing used.					
55	6 days.		15 days.			
56	3 days.		10 days.			
57	This depends largely on the heats. With a low heat after about a 75 days' run. With a high heat after about a 30 days' run.					
58	For a small plant, scurfing tile or brick and natural draft. Scurf until carbon shows distinct signs of loos ening.		Scurf with steam and air from 6 to 10 hours.			
59	No		No			

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42		
60	Use any scraper that has not too sharp an edge.				
61	Keep the clinker well rotted with steam. Use slicing bar and shake grate.		Use temporary fire bars and do the work as quickly as possible.		
62	Hot		Fire with hot coke when drawing retorts.		
63	Fill as often as possible.				
64	Water and steam. The water alone is not sufficient to rot the clinker, but is a help, and makes clinkering much easier by quenching the fire that may fall.		Water and steam.		
65	By hand work, and keep the lids off as short a time as possible.		Draw and charge with machine.		
66	It would be much more preferable to quench in conveyors.		Quench coke in conveyors.		
67	No		Yes		

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42			
68	No					
69	Every 4 hours.		Every 5 hours.			
70	No, except by rapid work.		No			
71						
72	Medium		Medium			
73						
74	Advantageous					
75	Since we cannot run on full capacity, it is saving in fuel. We never have stopped standpipes, the tar is of a better quality, and less carbon forms in the retorts		Reduction in amount of lamp black			
76	No		No			
77	Check stack damper.					
78	We never have trouble.		No			
79	High heats.		High heats.			
80			Yes			
81						

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42			
82						
83	4 times in every 24 hours.		Every 24 hours.			
84	Clinker after draws and fill during draws.		Fill at draw and clinker before draw.			
85	By hand.		By machine.			
86	14 minutes.		2½ minutes.			
87	Primary air is governed by slide set to give enough air for a high cherry heat in furnace.		Slide damper.			
88	Inspect personally and instruct foreman accordingly.		Foreman			
89	No		Yes			
90	Water drips over plate just fast enough to keep supply in ashpan. Steam introduced by ⅜ in. pipe through primary duct to back opening and well under back part of grate.		Above furnace door.			
91	No		No			

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TABLE 5—SO-CALLED HALF-DEPTH 6's—PART 4—*Continued.*

	No. 35		No. 42			
92	Never considered it.					
93			Glenboig			
94						
95	Yes		No			
96	Ahead of exhauster.					
97	Approx. 1%					
98	No					
99						
100						

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RÉSUMÉ.

Question No.	So-called full-depth 9's.	So-called full-depth 8's.	So-called full-depth 6's.	So-called ¼-depth 6's.	So-called ½-depth 6's.
12	4.80	4.88	4.85	5—(not corr.)	4.81
19	2036	4316 throughs	4200 throughs	1500	1762
20	15.03	15.59	15.8	17.	16.5
21	602	622 gross	.....	....	....
22	94.5	95.34	96.6	97.5	88.66
23	Coke 10 Coal 1 Mixed 1	3 1 1	4 1 1	2 1	11 1 4
24	....	13500 coke	....	....	....
25	Coke 281.5 Coal 441. Mixed 274.8	281.4 231. 274.8	288. 364. 274.8	....	380. 372.5 348.
55	31	44	32	19	17
56	13.6	25	16	12	8.5
57	41	37	62	7	44
69	4	5	4	6	2.6
80	Yes No	....	10 6	....	....
83	41 hrs.	40 hrs.	78 hrs.	64 hrs.	65 hrs.

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SIMPLE RULES TO GOVERN THE CARE AND OPERATION OF RECUPERATIVE BENCHES.

In this portion of my paper I will endeavor to formulate a set of rules so simple and concise that any retort house foreman can readily understand and follow them.

Time required to bring various kinds of recuperative bench installations to operating heat after being shut down, or when new.

Entire new stack of benches.

Time required for drying—15 to 20 days, depending on size, atmospheric and general conditions.

Time required after drying to bring benches to operating heat—5 to 10 days.

Entire old stack of benches, after being shut down for some time.

Time required for drying—5 to 10 days.

Time required after drying to bring benches to operating heat—3 to 5 days.

Single new benches in old arches.

Time required for drying—10 to 15 days.

Time required after drying to bring bench to operating heat—3 to 5 days.

Single old benches in old arches.

Time required for drying—2 to 3 days.

Time required after drying to bring bench to operating heat—2 to 5 days.

Precautions to be observed before starting drying out fire.

Brick up mouth-pieces, leaving hole about two inches square, to allow escape of moisture.

Close all dampers and sight-holes, except main flue damper.

Leave small air opening to underneath grate bars.

Drying out fire.

This may be started with wood kindling or hot coke. After starting, keep it up as a low (one foot deep) coke fire, at dull heat at first, gradually increasing air opening day after day, until at end of drying out period, a low

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(say two feet deep) but fairly bright fire exists. Feed this fire at frequent intervals with small quantities of fuel, not varying the heat any more than can be helped.

General Instructions during drying out period.

Watch expansion of brick work very carefully, and carefully loosen buck stays and tie rods from time to time.

Keep damper in ash door open to burn up any carbon monoxide that may be formed, or if this is not above fire, the fuel feeding door can be left open.

Be sure to have main flue damper wide open, so that all gases, moisture, etc., can readily escape.

At the end of drying-out period, the furnace portion of the bench should be at dull red heat.

To bring heat to operating conditions.

Clean and clinker fire thoroughly, and then add coke until a fuel depth of about two to two and one-half feet is secured.

Keep an ample amount of air going under the grate bars, so that fire will gradually brighten. Still keep feeding door open, but do not allow flames to come out of it. This can be regulated by main flue damper.

Keep dampers in ash door open.

Start water slowly dripping into ash pan.

See that primary air dampers are open.

Gradually increase depth of fire, until it is not less than about three feet deep just before firing.

When the combustion chamber begins to get hot the secondary air slides should be opened about three-quarters of an inch each. Close fuel feeding door.

When certain that carbon monoxide gas is burning at the nostrils, and the furnace is at a bright heat, fill the producer with fuel, open secondary air slides to an ample amount, and increase the water running to the drip pans and ash pan to full amount. Conduct the heating up process gradually, keeping up an excess of secondary air. If bench heats too rapidly, cut down primary air.

About one to two days before coming to full heat, remove brick work from mouth-pieces and charge retorts

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with small amount of slack coal, leaving caps on ascension pipes open at first, until ready to put hydraulic main into operation.

The charge of coal in the retorts prior to regular charges, should be one large charge of slack coal, left in at least twelve hours, to fill cracks in retorts, etc.

Regulation of Furnace during Operation.

Have the works superintendent or chemist set primary and secondary air slides after sufficient flue gas analyses have been made.

After that, no one but the superintendent or chemist should be allowed to touch these slides.

Since instructions for such analyses have been written and rewritten so often, I will not repeat them here.

Secure the most intimate mixture of water vapor and primary air that is possible with the construction under consideration.

If steam is used under the fire, run in one or more pipes, cap up at ends, drill hole in each cap of proper size to admit correct amount of steam per hour with the average boiler pressure carried at plant. The Superintendent or Chemist to determine proper size of holes.

Keep fires clean, deep and level throughout.

When firing, keep firing door open minimum amount of time.

Same rule applies to clinkering or cleaning. It is advisable to have stack dampers to be closed during these periods.

The main flue damper should be open only so far that there is a very slight pressure in the setting. Any slight crack or opening around a sight hole should therefore show a slight flame.

Usually when clinkering it is advisable to use false bars.

General.

See that all cracks in brickwork are promptly patched, that sight hole plugs fit tightly, that feeding doors into furnace (as well as other doors) are tight, and do not permit air leakage into benches.

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Keep top of stack clean, and free from dust, tar, etc.

Clean out the recuperators frequently with scrapers, steam jet, or, still better, by compressed air. This should be done every two or three weeks.

If leaks develop in recuperators, try to get them tight again by washing with a thin grouting.

Letting down settings or benches.

This is virtually the reverse process from starting up, but is simpler.

Put last charges into retorts about one hour before closing down.

Have fire in producer not over three feet deep.

One hour after last charge, close primary and secondary air slides, lute all openings, shut off water supply, shut all dampers, and allow bench or setting to cool down slowly.

When cool, pull coke, clean out fire, and leave things clean and neat, inside and outside of bench.

Retorts.

Keep well patched.

Keep well scurfed. Scurf a little too often rather than not quite often enough. Scurfing is probably best accomplished by compressed air, but steam jets up the ascension pipes, or the ordinary D-tile will do where compressed air is not available.

Coal charges must be put in properly. Get coal well into back end of retort, and have top practically uniform throughout. The shape of the top of the coal should be such as to best receive the radiated heat owing to the shape of top of retort. Have Superintendent determine this point.

When charging or drawing, keep mouth-pieces open as short time as possible.

Keep mouth-piece bolts properly tightened, and keep eccentrics on self-sealing lids in good working order.

Do not allow stokers to tighten eccentric levers by hammering with shovels, bars, etc. Do such work by hand.

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Ascension and Bridge Pipes, Hydraulic Main.

These should be kept thoroughly and regularly clean.

Have stokers push a gouge up ascension pipes after each draw.

Thick tar should not be allowed to accumulate in hydraulic main. See to this every day.

Keep every hand hole and cleaning hole in working order, as well as the overflows.

Inspect every operating device about the bridge pipes and hydraulic main every day, and if ammoniacal liquor circulation is used, see that all jets are clear, pumps in working order, etc.

General.

Keep all air, steam, water and other pipes tight.

Keep whatever machinery is used in good order and well oiled.

Keep none but good, first-class tools for the use of the men, and keep properly repaired.

Last, by all means one of the most important instructions, is in regard to cleanliness. Keep your house clean, thoroughly in repair all the time, have floors swept regularly, provide receptacles for rubbish, proper lockers, toilet and wash facilities for the men; keep tar off all bench and iron work, keep all dust off top of stacks, provide neat racks for tools, and endeavor to apply all the little useful devices for promoting ventilation you can.

Remember that cleanliness is the greatest simple factor tending to insure your success and the appreciation of superior officers.

Before concluding this paper, I wish to express my thanks to Mr. George S. Hessenbruch, of St. Louis, under whose direction a great deal of the reference and other matter used in the preparation of this paper was secured and arranged. I wish also to express my sincere appreciation to the officers of the Companies sending in answers, and to numerous gentlemen, both in this country and abroad, who have kindly sent me information and data for use herein.

References herewith appended.

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Discussion.

(In pursuance of the action taken by the Institute the following written discussions have been received from Mr. A. E. Forstall and Mr. Edward L. Rieha.)

Mr. A. E. Forstall: Under the heading, "Simple Rules to Govern the Care and Operation of Recuperative Benches,"

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Mr. Baehr states that, before starting the drying-out fire, the mouthpieces should be bricked up, leaving a hole 2 in. square to allow the escape of moisture, and that all dampers and sight holes, except the main flue damper, should be closed. My experience has never shown any necessity for bricking up the mouthpieces of the retorts, since as long as the bench is being merely dried out the mouthpieces can be left entirely open and as soon as the retorts begin to get hot, loss of heat can be prevented by closing the mouthpiece lids. There is thus no reason for incurring the expense involved in bricking up the mouthpieces.

Instead of closing all the dampers and sight holes except the main flue damper, only the air slides and the main flue damper should be closed, all of the sight holes being left open. The reasons for doing this have been very fully explained in the answers to the Practical Class, and the one treating of the operation of starting up a bench can be found in the Institute Proceedings at page 83 of Vol. I. The main flue dampers while closed at the start will, of course, have to be opened up later.

In the rules for bringing the heat to operating conditions, Mr. Baehr does not lay sufficient stress upon the necessity of always having the top of the fire bright so that any carbon monoxide which may escape from the fire will be ignited as soon as it comes in contact with air above the fuel bed. If this precaution is not taken there is danger of having an explosive mixture of carbon monoxide and air formed in the top of the furnace and the setting, while the top of the fire is cold, which mixture may be ignited with serious results when the fire brightens up.

The only statement in regard to the regulation of the primary and secondary air slides which Mr. Baehr gives is that these slides should be set after sufficient flue gas analyses have been made. This rule is all right where there is either a chemist connected with the plant, or the superintendent has sufficient chemical knowledge to enable him to make the required analyses. These conditions are probably found in only a very small percentage of the gas works in the United States,

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and, therefore, it is well to have a rule for setting these slides which does not involve chemical analyses. Such a rule has been given by me several times and can be found in an answer to the Practical Class, published in Vol. I of the Institute Proceedings, at page 153.

What seems to me another omission is the failure to give any rule for recognizing when the main flue dampers are properly set, except the statement that any slight crack or opening around the sight holes should show a slight flame. A rule which I think much better than this has been given in the same place as the rule for setting the air slides as referred to above.

In regard to the rule given by Mr. Baehr that when clinkering, or cleaning, the firing door should be kept open the minimum amount of time, I think that this rule should be made to read, the firing door shall not be kept open at all. With a good man in charge of the cleaning of the furnaces there is no necessity for opening the firing door during the cleaning of the fire, it being very easy to operate generator furnaces so that all the cleaning can be done through the lower clinkering door.

In giving the rules for letting down settings nothing is said as to the necessity of opening up the bridge.pipe covers and plugging the standpipes as soon as all the gas has been driven off the last charge of coal. It is necessary to do this in order to avoid any leakage of gas through the dip pipes and the standpipes into the retort. If such leakage occurs there is danger of an explosion which may do damage.

In speaking of the care of the ascension, bridge pipes and hydraulic main, Mr. Baehr states that these should be kept thoroughly and regularly cleaned. It would be well, with reference to the ascension pipes especially, to state what thoroughly cleaned means, since different people have very different ideas as to thoroughness. Thoroughly cleaned means that a test ring only one-quarter inch smaller in diameter than the interior of the pipe should pass freely down the pipe without meeting any obstructions.

MR. EDWARD L. RIEHA: It is very desirable at the present

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time that we adopt the word "recuperative" for gas benches of that construction and not "regenerative." The latter term has been discussed before and should be abandoned.

From all examinations made into various literature dealing with the subject, it resolves itself conclusively that only the word "recuperative" implies the correct interpretation.

Gas benches should be determined as half, three-quarter and full depth by the effective depth of the fuel in the furnace. It is in all instances understood that the depth of the recuperator be calculated and built to suit the amount of available gases coming from the setting, respectively the furnace. Their thermal capacities should be utilized to the fullest extent for preheating both the secondary and primary air, further also for evaporating the necessary steam. For such detailed figures I would refer to a paper by Geipert which appeared in the "Journal für Gasbeleuchtung" for the year 1906, page 459. Waste gases passing into the last outlet flue should not exceed a temperature of 600° Fahrenheit. As stated before, primary air should be preheated with the water-vapor. The idea that too high a temperature may result is entirely incorrect. This is regulated and in practice no case is on record where the air introduced under the grates caused fusion of the pyrites or silicates in the fuel. The formation of clinkers calls for a higher heat usually not attained at this point in a furnace of correct construction.

All reactions of furnace gases must be determined by proper control and should be as close to theoretical consideration as possible. The formations of CO and CO_2 in a producer are governed by temperature as well as distinct equilibrium which allows the chemical reactions to take place.

As regards the return flue gas method there is no doubt that the results obtained with this method are better than experienced in the majority of ordinary retort benches. The fuel consumption has been decreased to a large extent by its application and difficulties in clinkering being overcome.

However, we must bear in mind that in no instance has there been made comparison with the benches using water-vapor in the correct manner.

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In Germany ordinary recuperative benches are operating on ten pounds of fuel per hundred pounds of coal carbonized. Such results have been accomplished nearly ten years ago, and evidently are much better at the present time. The new "Pintsch-Hermansen" benches with "Rationelle" recuperators are using on an average nine pounds to one hundred of coal carbonized. Authoritative reports can be obtained from various gas works to verify the statements. I refer herewith to ordinary horizontal recuperative benches. It mainly depends upon the efficiency of secondary air recuperation, the proper homogeneous mixing of the water-vapor with the primary air which are preheated to a certain degree and then introduced.

The higher the furnace temperature, the more water-vapor can be introduced and correspondingly higher will be the flame temperature of the resulting gases for combustion.

There is a slight advantage to the introduction of CO_2 over that of steam. If, however, the vaporization of the steam is effected in the bench itself at the expense of its sensible heat (rather that of the waste gases) the efficiency of water-vapor is equal to that of carbon dioxide. Besides this the flue gas method requires exact control, and a large percentage of the waste gases must be returned for any furnace of ample dimensions. The latter usually carry only 18 per cent. of CO_2, and of this at least 50 per cent. must be brought under the grates to do good work. For large units it remains to be seen if this method will prove satisfactory at all, when adopted.

Purchasers of gas benches should lay down more specific and precise rules when making inquiries on their requirements. They should examine the value of the different constructions by inquiring into the efficiencies of the thermochemical processes involved.

THE PRESIDENT: The next business in order is the consideration of the report of the Committee on Meters. This report was made last year and comes up for consideration now.

MR. WALTON FORSTALL: Mr. President, if discussion is in order on that report, I would like to read the discussion of this report which has been written by Mr. William J. Serrill, of the Philadelphia Gas Works.

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DISCUSSION OF REPORT OF COMMITTEE ON METERS.

By William J. Serrill, Philadelphia, Pa.

Referring to the report of the Committee on Meters, which was presented at the last meeting of the Institute, and was by motion deferred for consideration until the present meeting, the writer believes that it would be a mistake for the Institute to adopt the standard recommended in the report for the following reasons:

First: The statement of the capacity of meters in terms of a differential pressure of 0.5 inches water column, is preferable to the use of 0.3 inches differential pressure. All meters can safely and satisfactorily be used at a differential pressure of 0.5 inches. Consequently, the capacity should be stated in terms of this unit, because the ordinary conception of the word capacity is the maximum safe working capacity of the machine. In all meters of modern construction, a differential pressure of 0.5 inches is the maximum safe working capacity.

Second: The capacities proposed in the five sizes recommended by the Committee are too close together. Gas companies are not in position to determine, with any degree of accuracy, the maximum rates of consumption of the consumers. Consequently, the determination of the sizes of meters to set in specific cases is not an exact science. Under these conditions there is no advantage in having any two sizes, the capacities of which are close together. Another objection to the narrow ranges between these capacities is that it will require too many sizes to cover the total range of capacities demanded by the business. Consistent with meeting the requirements, the fewer the sizes in a standard of meters, the better.

Third: The smallest capacity recommended by the Committee is too great. Experience has shown that the present 5-light meter, which has a capacity of 70 cubic feet per hour under 0.3 inches differential pressure, is large enough to sup-

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ply from 80 per cent. to 90 per cent. of the consumers in most cities. Any meter having a capacity of 100 cubic feet under 0.3 inches differential pressure, will cost more than the present 5-light meter. Consequently, the present 5-light meter should be a part of any standard.

Fourth: The largest capacity recommended by the Committee is very much too small. The Committee apparently recognize the need for larger sizes, but believe there is not sufficient experience to admit of a proper design. It would be a mistake for the Institute to adopt any standard until it could adopt a complete one.

Fifth: Any standard of meters should contain not only a list of capacities, but also a list of the two important physical dimensions of the meters. These are the height of the meter, measured from the bottom of meter to top of screws, and the distance between the screws, centre to centre. In ordering, handling and setting meters, this information regarding physical dimensions, is almost as important to a gas company as is a knowledge of capacities. A standard of meters which does not contain a list of names or designations for the different sizes, is incomplete. Some briefer name than the figure showing the capacity is required.

Sixth: An important reason why the Institute should not adopt the standard recommended by the Committee is the fact that the "A" meters, which have now been on trial for over two years, have proved successful and have already practically been accepted as a standard by many gas companies. "A" meters of different sizes have been made and put in use, probably to the extent of over 50,000. The mere fact of the existence and use of these meters constitutes an important claim for the adoption of the "A" series of meters as the standard of the Institute.

The writer has presented to this meeting a report on the experience with "A" meters to date, and he believes that these meters with the 5-lt meter should constitute the standard. Such a standard would be as follows:

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STANDARD GAS METERS.

Name	Capacity*	Height°	Width§	Size Screw
5–lt	100	16	11⅛	5–lt
5–A	175	16	11⅛	5–lt
10–A	375	17½	13⅛	10–lt
30–A	875	25	18⅝	30–lt
60–A	1800	33¼	25	60–lt
150–A	3400	42¾	32	150–lt

* With 0.5" differential pressure and a gas with specific gravity of .55.
° In inches from bottom of meter to top of meter screw.
§ In inches from centre to centre of meter screws.

The Institute, in adopting a standard, should not attempt to go into greater detail regarding the construction and design of meters than is contained in the table here given. In the nature of things, all meter manufacturers cannot be expected to construct meters, the details of which are exactly the same. So long as the capacity and leading dimensions are attained and adhered to, each manufacturer should be free to follow his own designs, and, in the long run, the best make, or makes, of meters will win out.

The writer takes this occasion, however, to urge upon the manufacturers, in the interest of simplicity, not to call any meter an "A" meter unless it has the capacity and the dimensions given in the above table. If any manufacturer places a meter on the market, which differs from these, it would be advisable for him to adopt a different name, preferably some other letter of the alphabet.

The Institute should either adopt the standard of meters here described, or postpone the adoption of a standard until a further trial is made of "A" meters.

THE PRESIDENT: Is there any further discussion of the report of the Committee on Meters?

MR. JOHN GRIBBEL: Mr. President, in view of the fact that there has been so much preliminary work already done in testing larger capacity meters, and inasmuch as no definite results in the way of formulating a standard have yet been attained, it seems to me that it would be wise for this Institute not to commit itself to any standard until further light has been

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gotten on the subject. I would move, therefore, that the report of this committee be received and laid upon the table for future action, and that the committee be discharged with thanks.

A MEMBER: I would second the motion of Mr. Gribbel. While, undoubtedly, good has been accomplished, the results so far have been very much under my idea of what ought to be, and what, as has seemed to me, were the ideas of others, I think that the recommendation named by the committee in the statement just read is not exactly correct, and therefore I am very strongly in favor of letting this matter rest over for a time, and I would therefore second Mr. Gribbel's motion.

MR. H. C. ADAMS: Mr. President, I would move to amend that motion by instead of moving to put it on the table have it referred, as has been our custom in such cases, to the Technical Committee.

MR. GRIBBEL: I think that is a better proposition. I will accept that amendment.

THE PRESIDENT: That the whole matter be referred to the Technical Committee as provided by the Constitution, and that the present committee be discharged with the thanks of the Institute. That is the motion which is now before the house as I understand. Those in favor will please say "Aye." Contrary minds, "No." Carried.

The next business in order is the report of the Nominating Committee on the Secretary-Treasurer. Is that committee ready to make any further report?

NOMINATING COMMITTEE ON THE OFFICE OF SECRETARY-TREASURER.

MR. A. P. LATHROP: Mr. Chairman, the Nominating Committee at their meeting decided to accept the recommendation of the special committee which was appointed to select a secretary. I understand that that committee has no report to

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make, but that the Directors at a meeting yesterday made a recommendation which I have no doubt will be acceptable, although I have been unable to see the other members of the Nominating Committee to consult with them about it. I assume, however, that in voting to accept that report of the special committee they will accept the recommendation of the Board of Directors. I understand from Mr. Dunbar that the Directors recommended that no person be nominated to serve as the active Secretary-Treasurer.

THE PRESIDENT: I suppose that we may accept as the report of the Nominating Committee the recommendation of the Directors for the ensuing year.

MR. LATHROP: I cannot say as to that, Mr. President, except for myself, but I do not think that the members of the committee would have any objection to that recommendation of the Directors.

THE PRESIDENT: I would like to have this very regular.

MR. LATHROP: I have tried to find out, but have been unable to see the other members of the committee.

THE PRESIDENT: The Constitution provides the way for a nomination to come before this body. I think we should make every effort to keep within the Constitution. I would like to ask if Mr. Lathrop and the members of the Nominating Committee agreed not to make a nomination for Secretary-Treasurer until they had the recommendation of the Board?

MR. LATHROP: Yes, sir.

THE PRESIDENT: Following that suggestion, then, I will read the action as taken by the Board, and then perhaps the chairman of the Nominating Committee will be willing to make no further report for the Nominating Committee.

President Clark read as follows: "A special meeting of the Board of Directors was held at the New Willard Hotel after

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the adjournment of the Institute, Thursday afternoon, October 17th, 1907, President Clark presiding.

"On motion of Mr. Lynn, duly seconded and passed, it was voted that the Board of Directors recommend to the Nominating Committee that they select as a Secretary some person who is a member of the Institute, who will regard the position as honorary and serve without compensation for the ensuing year, and that the incoming President be empowered to engage an assistant to the Secretary and Treasurer, or clerk, to look after the headquarters in New York, at a salary of not exceeding $3,000 per annum, and expenses." That is the action which was passed by the Board.

MR. LATHROP: I had not seen that, and I did not know what the terms of the vote were. I speak only for myself, individually, as a member of the committee, but for myself, I should be very glad to accept that.

THE PRESIDENT: Under that vote, the Nominating Committee should agree upon some person to act as Honorary Secretary. Would you kindly make an effort to see the others so that we may get this disposed of this morning?

MR. LATHROP: I do not know whether I can find the other members of the committee, Mr. President.

THE PRESIDENT: We can cover this by a nomination by petition, I presume.

MR. LATHROP: That will be acceptable to the committee, I think.

THE PRESIDENT: While I have this matter of the report in hand, I will read the balance of it. The Board further reports that

"On motion, duly seconded and passed, the Board voted to pay Mr. T. C. Jones for his services as Treasurer during the past year the sum of $600 and his expenses."

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MR. WILLIAM MCDONALD: Mr. Chairman, I move that that action be approved.

Motion seconded.

THE PRESIDENT: Gentlemen, you have heard the motion. Any remarks? Those in favor please say "Aye." Contrary minds, "No." Carried.

The next business in order is the "Report of Progress of 'A' Meters." Mr. Forstall, will you read that?

MR. WALTON FORSTALL: This is a report which has been made by Mr. Serrill, of the Philadelphia Gas Works, in fulfillment of a promise made at Washington three years ago, that the Philadelphia Gas Works would keep the gas fraternity in touch with the results obtained from the use of "A" meters. I do not believe it is necessary to read the report. It will, however, repay careful study. It may be summarized by saying that "A" meters have proven very satisfactory, but that certain weaknesses of design have developed which are now being corrected.

REPORT OF PROGRESS ON "A" METERS.

BY WILLIAM J. SERRILL, PHILADELPHIA, PA.

At the meeting of the American Gas Light Association, held in Washington, in October, 1904, the "A" meter was proposed in a paper read by Mr. B. H. Spangenberg, of Philadelphia. During the discussion of the paper, the writer promised that The United Gas Improvement Company would construct (say) 1500 of the proposed meters, put them in use, and report on their action at a future meeting of the Association. It required nearly twelve months after the date of that meeting to complete the designs, and construct the meters. Consequently, this report of progress covers the experience gained with "A" meters, a few of which have been in use for a period of two years, but the greater number of which have been in use for a shorter period.

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"A" meters of different sizes have been purchased, and are now used by a number of the plants that are operated by The United Gas Improvement Company, but at only three of the plants is a sufficient number in use to make the experience with them of value. These are Kansas City, Mo.; Kansas City, Kan., and Philadelphia, Pa. In these cities there are now in use about the following number of "A" meters.

Kansas City, Mo.	13,500
Kansas City, Kan.	7,500
Philadelphia	2,000

These meters are of the type built by Helme & McIlhenny and The John J. Griffin Company, of Philadelphia. The details have been perfected by these companies, in constant communication with the engineering staff of The United Gas Improvement Company. Consequently, the results given below refer entirely to this particular type of "A" meter. This explanation is made because it is well known that a number of meter manufacturers throughout the country have put "A" meters on the market. The United Gas Improvement Company has not tried these meters and has little knowledge regarding them. The only exception to this statement consists of the purchase of about 1200 "A" meters from the Maryland Meter Company. These were of the same pattern as those made in Philadelphia, and are, consequently, really the same type of meter.

The "A" meters in Kansas City, Mo., have been principally started passing artificial illuminating gas, and have since been used with natural gas. In Kansas City, Kan., the "A" meters have been used mostly on natural gas from the start. The results obtained in these cities have been satisfactory; the tests of the meters are as good as those obtained with ordinary meters. For instance, in Kansas City, Mo., 1339 "A" meters of all sizes have been removed for one cause or another, and tested during the last two years. These tests show as follows:

Average error of all "A" meters tested, 2.2 %
Net error of all "A" meters tested, 0.48% slow

In Kansas City, Kan., during the past two years, the number of "A" meters removed and tested is 1042. These tests show as follows:

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Average error of all "A" meters tested, 0.950%
Net error of all "A" meters tested, 0.032% slow

These figures are very satisfactory.

In Philadelphia the number of "A" meters removed and tested is 475. These tests show as follows:

Average error of all "A" meters tested, 2.54%
Net error of all "A" meters tested, 2.34% slow

These Philadelphia figures are not what they should be. A thorough investigation has been made in order to determine the cause for the slowness of "A" meters in Philadelphia. In making this investigation, 25 "A" meters were selected which were known to be used at or near their rated capacity, and which have passed since they were set, a large quantity of gas. These meters were ten 5-A, ten 10-A and five 30-A. They were removed, dismantled, and subjected to a careful examination of the working parts. This examination quickly revealed the causes of the meters going slow. These were the weakness of two of the bearings, viz.,—the hole in the short flag arm where it goes on the tangent post, and the hole in the bridge, or king post, where the crank passes through same. In meters examined, these bearings show sufficient wear to account for the slowness disclosed by the tests. Arrangements are being made with the manufacturers to strengthen these bearings, and the writer has little doubt that when this is properly done, the "A" meter can be depended upon to hold its proof at least as well as the old type of meter.

It is interesting to recall that the weakness thus developed in the "A" meters is the very weakness that was to a certain extent predicted in the original discussion at the Washington meeting. It was claimed that the bearings in the meter were not strong enough to stand the increased strains brought about by the larger moving parts. The answer was that the bearings should be designed to meet the strains. Evidently, in the first attempt, the bearings were not designed strong enough, but it is interesting to note that in the larger sizes of meters, such as 30-A and 60-A, where it was necessary to re-design these bearings, no such weakness has developed. An examination of the details of the figures of tests above given, shows that, in Phila-

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delphia, the 30-A and 60-A meters hold their test and do not show this tendency to run slow with use. The weakness is shown in the 5-A and 10-A sizes, the bearings of which were not re-designed, but were somewhat enlarged over the original type. There is no difficulty in making the bearings of these smaller sizes of meters sufficiently strong to sustain the wear.

At the present writing, the exact construction of the strengthened bearings has not been determined. In the 30-A, 60-A and 150-A meters, the king post, or bridge, is made of brass; in the smaller sizes, it is of soft metal, and it is probable that a mere change of material will effect the desired result. The bearing at the end of the short flag arm it is proposed to strengthen by the use of a loose case-hardened sleeve, fitting over the tangent post, the hole in the end of the flag arm being enlarged to fit over the sleeve. The investigations have further shown that the valves, or valve covers, of the 5-A and 10-A sizes can to advantage be made somewhat lighter.

On the whole, the writer believes that the "A" meter, with its largely increased capacity per unit of cost, marks a great step in advance in the measurement of gas. There is every reason to be gratified with the large measure of success that has attended the inauguration of these meters, and to believe that the modifications in construction now under way will render the success complete. There is no indication that any harm is done to the meter diaphragm by the increased work that it is given to do, nor is there any indication that the large valves and seats wear more rapidly, or are more apt to leak, than are the smaller ones.

In view of the experience with "A" meters to date, it is difficult to see how any gas company could justify to itself the purchase of 45-light meters when it can obtain 10-A meters which will do the same work for less than half the cost. Again, how can a gas company afford to purchase 100-light meters when 30-A's of equal capacity cost about one-third as much. In a similar manner the 300-light and 500-light meters can be replaced by the 150-A, at a greatly decreased cost. The economy in all of these substitutions is not confined to the first cost of a meter, as the decrease in weight and the decreased cost of

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connections, are material factors. The abolition of flanged connections is in itself an important item of saving.

When the "A" meters were first proposed, it was thought that if successful they would completely replace the old style of meters. Further experience has somewhat modified that view. It is evident that the 5-light meter is large enough to take care of the consumption of a large percentage of the gas consumers in every city, and, as the 5-A meter, although of the same external dimensions, is somewhat more expensive to construct, it is evident that the 5-light meter will, and should, continue to be used in places where it is of sufficient capacity. Consequently, the modified standard schedule of meters, in the writer's opinion should be as follows: 5-lt, 5-A, 10-A, 30-A, 60-A, 150-A. These six sizes will answer all requirements of any gas company. Further details regarding this proposed standard schedule will be found in the writer's discussion of the report of the Committee on Meters, which will form a part of the proceedings of this meeting. (See p. 899.)

THE PRESIDENT: The next business in order is the report on "Experience with Dipping Diaphragms in Philadelphia," by Mr. W. A. Castor.

EXPERIENCE WITH DIPPING DIAPHRAGMS IN PHILADELPHIA.

BY W. A. CASTOR, PHILADELPHIA, PA.

On September 1, 1907, there were 127,000 meters containing neutral machine oil—about 45 per cent. of the total meters in service.

The system of introducing oil into the meters was started July 1, 1905, at our Meter Repair Shop, and in the six district meter shops a year later.

All meters are now oiled before same are put in service.

Meters, 150-light or over, are sent to the Repair Shop for testing and oiling.

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A ¼-inch hole is punched in each side of the partition on outlet side of meter, midway between the partition and front and back cases and ¾ inch above the bottom. The meter is drained if necessary, and a measured quantity of oil, as shown in the table given below, is poured into each diaphragm chamber through the punch holes.

In some meters the diaphragms are set by the manufacturers to clear the bottom of the meter. This clearance varies greatly in different makes of meters. When the meter cases are not removed, or the height of the diaphragm is not definitely known, it is our practice to place an extra quantity of oil in each diaphragm chamber to insure the diaphragms dipping in same, and then sweat in a round-headed, tinned rivet in each punch hole. These meters are then known as Class No. 2 meters. When the diaphragms are exposed and the clearance between bottom of diaphragm and bottom of meter is $^3/_{16}$ inch or less, a minimum quantity of oil is put in, and a flat-headed, tinned rivet is sweated in each punch hole. These meters are then known as Class No. 3 meters.

Meters that have not had oil inserted are known as Class No. 1 meters.

The following quantities of oil are to be poured into each diaphragm chamber of Class No. 2 meters, or when making a meter Class No. 2:

Size of Meter	Quantity of Oil (Ounces)
3–lt	20
5–lt	24
10–lt	34
20–lt	22
30–lt	68
45–lt	38
60–lt	47
100–lt	60
150–lt	98
200–lt	98
300–lt	124

The following quantities of oil are to be poured into each

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diaphragm chamber of Class No. 3 meters, or when making meter a Class No. 3:

Size of Meter	Quantity of Oil (Ounces)
3-lt	10
5-lt	10
10-lt	16
20-lt	22
30-lt	32
45-lt	38
60-lt	47
100-lt	60
150-lt	98
200-lt	98
300-lt	124

Samples of the oil are taken from the shipments received, and submitted to our Chief Chemist to be tested for acidity, viscosity, and congealing point. There has been no trace of acid found in any of the samples submitted to date. The specific gravity of this oil is .87, congealing point of 35 degrees to 38 degrees Fahrenheit, viscosity 1.9 at 100 degrees Fahrenheit.

Oil drained from meters, brought in from service, is not used again in the meters, as it contains more or less condensation.

The practice of introducing oil into the meters has resulted in a great reduction of the number of meters sent to the Repair Shop by the district shops. During the period covered by this report, the tests of all meters made in the district shops, resulted in the sending to the Repair Shop of about 3 per cent. of the dipping, and 11 per cent. of the non-dipping meters. As all meters will be changed to the dipping classes within a few years, it is plain that a considerable saving will be effected.

The non-dipping, or Class No. 1, meters removed from service, and proving within the adjustment limits, are not subjected to the slow motion test until after the oil has been put in the meter. A careful investigation has shown that more than 50 per cent. of the slow motion leaks on Class No. 1 meters will be remedied simply by the absorption of oil by the diaphragms.

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The diaphragms are undoubtedly preserved by the oil which keeps the leather soft and pliable at all times and protects it against the action of the gas vapors.

A recent examination of a number of diaphragms, which had been in the meters from two to ten years previous to oiling, and from one-half to one and one-half years after being made "dipping" diaphragms, showed the leather in each diaphragm thoroughly saturated with oil and no evidence of any injurious action due to the neutral machine oil. Diaphragms originally oiled with neutral machine oil, and which have been in service for two years or more, show no depreciation on examination.

An investigation, covering a period of several months, showed that the oil, when introduced into non-dipping, or Class No. 1, meters, removed from service, caused a marked change in proof after standing from 10 to 20 days after the oil was put in. Slow meters proved faster, and fast meters generally proved slower.

This information enabled us to make a change in the O. K. limit of error previous to taking off the top for adjusting purposes, thus taking advantage of the effects of the oil, thereby saving the expense of unnecessarily taking off the tops of a large number of Class No. 1 meters for adjusting.

A considerable saving is effected at the Repair Shop, due to the fact that it is not thought necessary to expose and examine the diaphragms of dipping meters received from the district shops, unless the tests warrant such procedure, while, on the other hand, diaphragms in non-dipping meters, which had been in service six months or more, were exposed, and in many instances, renewed. We are thus enabled to save the expense of removing and replacing the cases and the frequent renewal of diaphragms, feeling safe in allowing the dipping diaphragm to remain in the meter until a test shows that it actually demands attention.

It is important that enough time should be allowed for the oil to saturate the diaphragms of Class No. 1 meters changed to Class No. 2, before making the check test after putting in the oil. Ten days is sufficient time for meters 10-light or smaller, and twenty days for meters 20-light to 100-light, in-

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clusive. If longer time can be conveniently allowed for 60-light and 100-light meters, it is advisable to do so. It is doubtful if the oil will reach the top of diaphragms of 150-light meters or larger when the leather has been bleached and the pores of the leather are more or less choked up. Experiments are now being made to lift the oil to the top of the diaphragm of large meters by mechanical means.

The following comparison of proof of dipping meters as compared with proofs of non-dipping meters after removal from service, shows the decided superiority of the dipping meters.

COMPARISON OF TESTS OF DIPPING AND NON-DIPPING METERS.

(9-1-06 to 9-1-07)

	DIPPING	NON-DIPPING
Number tested,	12,876	51,041
Average error,	1.6%	2.9%
Net error,	0.77% slow	1.5% slow

The net error of dipping and non-dipping meters from July 1, 1905, to September 1, 1906, is as follows:

DIPPING		NON-DIPPING	
Net error,	.74% slow	Net error,	1.0% slow

The net error of dipping and non-dipping meters from July 1, 1905, to September 1, 1907, covering the entire dipping period, is as follows:

DIPPING		NON-DIPPING	
Net error,	.76% slow	Net error,	1.3% slow

The following shows the percentages, by class, of the total meters removed from January 1, 1907, to September 1, 1907, which tested within correct limits, *i. e.*, 1 per cent. fast or 1½ per cent. slow:

No. 1 (Non-Dipping)	33.4%
No. 2 (Dipping)	66.5%
No. 3 "	68.6%

The Class No. 2 meters may be safely said to compare with Class No. 1 meters, as to age of diaphragm and of meter. We may therefore expect that the results of the tests of Class No. 2

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meters, as shown above, are what we may expect from all meters in the long run after reaching the oiling or dipping basis.

The following table shows the percentage of each class of meters removed and tested from January 1, 1907, to September 1, 1907, that was sent to the Repair Shop from the district shops.

67% of Class No. 1
26% of Class No. 2
20% of Class No. 3

A like summary for the month of August shows:

67.0% of Class No. 1
15.5% of Class No. 2
8.0% of Class No. 3

Our experience has proven that dipping meters record within smaller limits of error, that diaphragms are preserved, that the proof of the meter remains fairly constant under all conditions, and that cost of repairs, which were formerly due to diaphragm troubles, has been greatly diminished. All the advantages claimed for the dipping of diaphragms in oil by Mr. John Rusby in his paper read before this body last year, have been fairly realized in actual practice.

THE PRESIDENT: Another paper on this same subject is by Mr. George Beadenkopf, of Baltimore. I think Mr. Miller will read that paper.

MR. A. S. MILLER: Mr. President, Mr. Beadenkopf was detained by illness in his family. This report is merely a report of progress. Mr. Beadenkopf did not feel that he had anything new to add, but he felt confident that something would be said in the way of discussion which would contribute to our knowledge on this subject.

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STATEMENT CONCERNING THE EXPERIENCE OF THE CONSOLIDATED GAS, ELECTRIC LIGHT & POWER COMPANY, OF BALTIMORE, WITH "DIPPING METERS."

By Geo. Beadenkopf, Baltimore, Md.

On January 3rd, 1907, this Company began using in its consumers' meters "Dipping Oil." This oil being known commercially as No. 4 Neutral Machine Oil: an oil free of acid.

The oil is introduced through two holes near the bottom of the meter, and an amount sufficient to allow the diaphragms to dip into it about $^{5}/_{16}$ of an inch is placed in each meter. The quantity for a 5-light meter being about 20 ounces, or 5 gills, where the diaphragms do not drag on the bottom of the meter.

After the oil has been placed in the meters, and the holes closed with rivets (the rivet heads being covered with solder to make them tight), and before the meters are placed in service, they are set aside for about three days to see that no oil leaks out of them.

From January 3rd, 1907, to August 15th, 1907, 16,766 meters have been oiled and placed in service; and of this number 304 have been removed for various causes. The average test for these 304 meters (some of them having been O. K. Meters), when they were set, was 100.69; and when removed, the average test showed 100.72:—275 of the meters removed ranging between 98 and 102.

Of the oiled meters examined, which have been brought in from service, there have been no signs of bleaching of the diaphragms; whereas meters which have not been treated with oil, frequently show signs of bleaching after several months' service.

Of oiled meters which have been brought in from service and opened, and have been exposed to the air from two to five days, the diaphragms showed no signs of drying out or bleaching, but remained soft and pliable.

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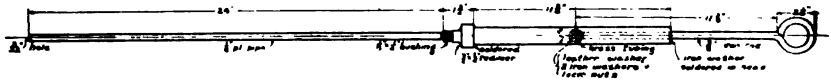
The amount of oil and condensation found in meters after from three to six months' service, varying as to the location of the meter, has been found to be about 25 ounces, an increase over the amount of "Dipping Oil" originally put in of about 25 per cent. This mixture will sometimes flash, when passing a light over it. It has been the practice with meters brought in from service, to replace this mixture with fresh neutral oil, in all meters which have been in service three months or over.

One hundred and seventeen meters, unoiled, which have been brought in from service and tested, and found to test between 99 and 102, were treated with oil and set aside in the shop for ten days, and again tested with the following result:

No change from original test, 33 meters.
Went faster than original test, 37 meters.
Went slower than original test, 47 meters.
Average of tests before oiling, 100.15.
Average of tests after oiling, 100.31.



In all of the meters referred to as having been treated with neutral oil, the diaphragms were originally oiled with the usual diaphragm mixture, viz: 2 parts Sperm Oil, 1 part Rape Seed Oil and 1 part Neatsfoot Oil; but a test is now being made of a lot of new meters, the diaphragms of which were treated with no other oil than the neutral oil; these meters having been in service such a short time, that an examination has not been made of them.

Meters which have been oiled must be kept right side up, and must not be handled in any other than an upright position, or nearly so. To avoid up-ending the meter when removing the condensation from the inlet and outlet pipes of the meter, a syringe or suction pump is used—a sketch of which accompanies this statement.

We find that the average cost of oiling meters of all sizes is about 5¼c. per meter, including all labor, supervision and material. The oil itself costs an average of about 2½c. per meter.

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MR. A. S. MILLER: I would say further, Mr. Chairman, that there is one point that Mr. Beadenkopf did not put in here. He found it necessary to put some form of seal on the rivet heads, as in some cases the rivets had been taken out and the diaphragms punctured.

DISCUSSION.

THE PRESIDENT: Gentlemen, those two important papers are before you for discussion.

MR. J. D. MCILHENNY: Mr. President, I think both of these papers will merit consideration by gas men. I think that the conclusions are correct, and I am going to adopt the same plans in one of the plants with which I am connected. I am very much pleased that so much work has been done in endeavoring to preserve gas meters, and as I look upon it I am confident that more attention will be paid to meters in the future than has been paid in the past. Many repairs which have been given to meters might have been avoided, or done with much less expense to gas men if our knowledge of this subject had been as great as it now is. It is going to be a matter of considerable importance to gas men to realize that meters should be handled carefully, and thoughtfully, and the sooner that time comes the better it will be for correct registration and for a reduction in expense.

I think those who have been engaged in the formulation of the plans detailed in these papers are entitled to very great thanks.

MR. W. H. GARTLEY: I think possibly, Mr. Chairman, it might be well to restate a little of the history which led up to the idea of dipping meters. There was a conviction in Philadelphia several years ago that the gas as manufactured was having a disastrous effect upon the meters, and it led to an investigation to find out what was happening. There was a clue, and we took the oiled leather of a diaphragm and suspended it in an ordinary glass Wolff's bottle, and we then passed gas through the bottle, first chilling it; that is to say, the gas was

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cooled when it entered the bottle to a temperature lower than what it had been at any previous time, and, in consequence, there was a corresponding deposition of vapor. We found that all of those condensed vapors had an effect upon the oil that was used upon the leather, dissolving it, and the result was that in a very short time the leather was entirely bleached. The gas was then warmed to a higher temperature; that is to say, the gas was first chilled, and then warmed as it went into this bottle, and the result was that the vapors that were on the leather were reabsorbed by the gas, and the leather became entirely dry, and looked as it did before in the original skin. Now the argument was that that was what was going on in a large field among consumers' meters. During the fall, at which time the temperature of the ground remained high, the cellars of the houses where the meters were located were cool, and there was consequently a reduction of temperature in the gas when it passed from the warm ground into the meters in the cooler cellars and there was the expected action on the meter diaphragm leather. There was a deposition of vapor and a dissolving of the neatsfoot oil. As the winter came on and the cellars were heated, the gas being cooled in the ground, an opposite effect was going on, and the meters were dried out. Now the question of how to remedy that took about three years to find out. There were a great many things tried by the research committee of the United Gas Improvement Company, which I suppose you will never hear of, but the result was that it was finally decided that if the inaccuracy of the meter was increased by the drying of the diaphragm, the cure lay in the introduction of a little non-evaporating oil in the bottom of the meter case, as this oil would, when the diaphragm started to dry out, be lifted by capillarity into the leather, thereby re-oiling it.

THE PRESIDENT: If there are no further remarks on this subject, we will proceed to the next paper, "A New Carbonic Acid Gas Indicator," by Mr. Charles D. Robison.

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A NEW CARBONIC ACID GAS INDICATOR.

By Charles D. Robison, Nyack, N. Y.

Since the earliest investigation aiming to develop the most economical method of operation of water gas apparatus, it has been conceded that the production of carbonic acid gas must be kept down to a minimum and that any unusual increase of this gas is the surest indication that something is wrong in the method of operation However, constant determination of this gas has not been an easy matter, particularly with the smaller works that cannot afford the constant services of a chemist. There have been several indicators and recorders put upon the market, but they have been high in price, rather bulky, and require a considerable lapse of time from the moment the gas is produced in the furnace until the indication is given. Some months ago, the writer's attention was called to a carbonic acid indicator that had just been invented by Professor Jones, Chemist for the Metropolitan Street Railway of New York, to be used in connection with steam boiler operation. This was a comparatively small and simple affair, apparently easy to operate, and as its adaptability to the gas business immediately impressed me, one was at once purchased and set up at the works of the Company with which the writer is connected. It has met my expectations in every way. Indications were given in 40 seconds after the gas had entered the machine and in less than a minute after it had left the generator.

The following cut is a top view showing the interior, and the principle of operation can best be explained by quoting from the Instructions for using the apparatus: "Two streams of gas to be analyzed are made to pass through solutions in two chambers at the same tension. The carbonic acid gas to be estimated is removed by absorption in one chamber and not in the other. This changes the tension in the chamber in which the absorption takes place. The tensions of these two chambers are made to oppose each other by connecting each with one end of a manometer, and the difference of tension of the gas in the two

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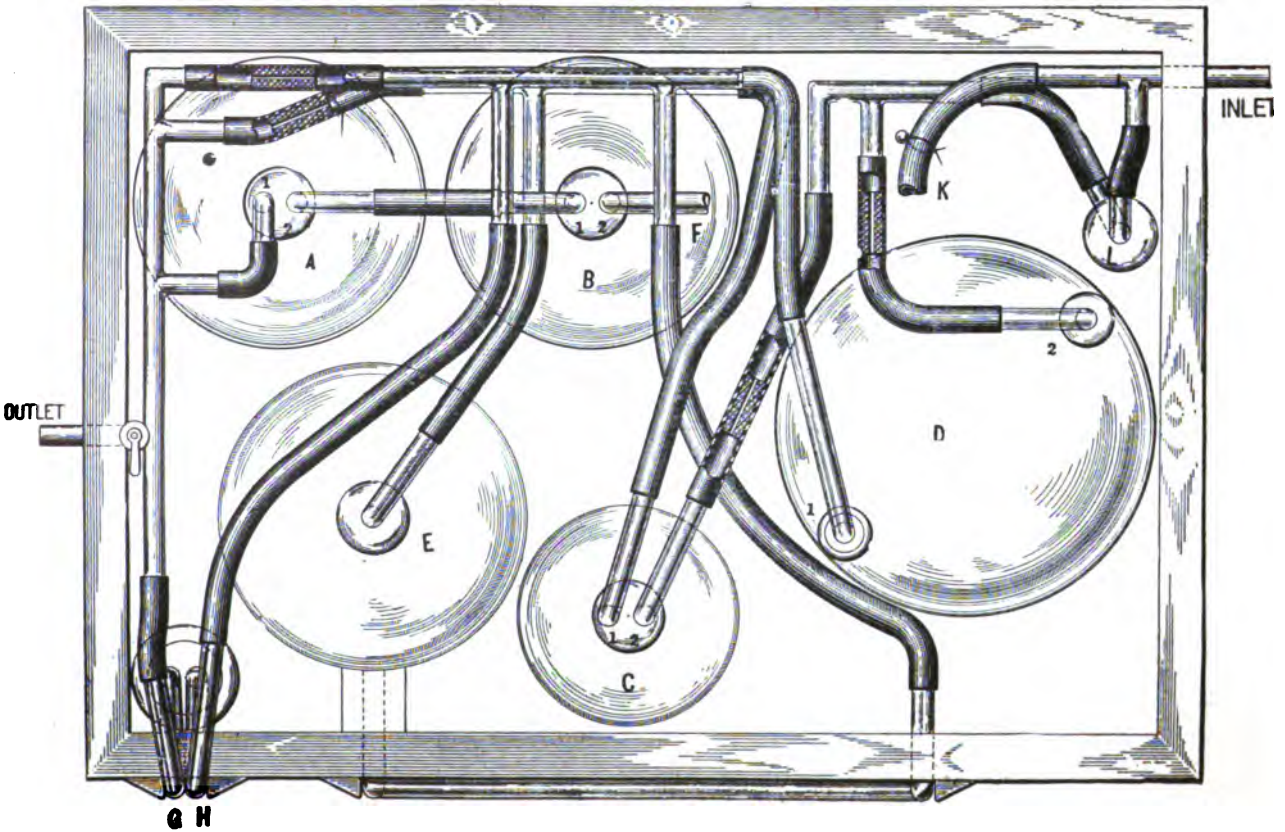

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chambers is shown on the manometer scale, which is arranged to indicate the percentage of carbonic acid in the gas."

The method of charging the apparatus and putting it in action is a simple one. Pour carefully into the bottle "E" kerosene or coal oil of 150 degrees fire test, until it shows on the indicating tube on the front of the box and stands exactly at the "O" mark.

Dissolve the contents of the package of sulphate of zinc in 34 ounces of water (this gives a solution of about 38 degrees Beaumé gravity); fill bottles "A" and "B" with this solution up to the top of the mark. Remove the stopper from bottle "C" and fill to the mark with the oil furnished. Dissolve two pounds of stick caustic potash in 62 ounces of water, remove the stopper "D1" and fill this bottle to the top of the mark with the potash solution. Then put one ounce of glycerine into the small bottle in the left-hand corner into which the tubes "G" and "H" are inserted.

The instrument is now charged, and, after standing to allow the temperatures to equalize, is ready to be adjusted as follows: The small aspirator which is furnished with the indicator is connected to a water supply of at least 30 pounds pressure, giving a fairly constant flow of clean water to insure no stoppage in the aspirator and fairly constant suction on the indicator. This having been done, connect the suction tube with the outlet of the indicator. Now open the cock inside the box slowly until the air bubbles through "A" and "B" in a quiet, steady stream. After this has been running a few moments, the glycerine standing in this column will be seen rising in tube "G." The height of the glycerine standing in this column can be regulated by increasing or decreasing the seal on tubes "A2" or "B2" by raising or depressing them. Next notice if the glycerine in tube "H" stands at the mark. If it is too high or too low, it can be adjusted by using tube "D2" in the same manner as "B2." When these two adjustments have been made, remove the clip from the rubber "F," letting it rest on the brass tube. The oil in the indicating tube is now released and will probably stand too high or too low; this is again brought to the "O" mark by using the tube "C2", but in the reverse manner.

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Depressing the tube lowers the oil and raising it brings it up. The apparatus is now ready for use and the box may be closed. It is important to note that the indicator should be situated so that no sudden change of temperature takes place within the box while this adjustment is being made. The box should therefore be protected from sudden drafts of cold air.

Connect a ¼-inch iron pipe to the gas inlet of the carburettor, carry it close to the indicator, and from there allow it to open out of the building. A tap is made in this pipe where it passes the indicator, and a small stream of gas through a rubber tube is taken into the bottom of a bottle which is open at the top. Into this bottle insert the tube leading from the inlet of the indicator; the purpose of this connection is that the indicator may not be subjected to the violent changes in pressure which take place in the generator when a change is made from a "blow" to a "run," and to allow the water which condenses from the gas to be collected in the bottle and not drawn into the apparatus. As soon as the gas from this bottle reaches the absorption bottle, any carbonic acid it may contain will at once be indicated on the manometer. The operation is now continuous, indication being given constantly.

In putting our indicator into operation, the following precautions to be observed were developed: The indicator should not be subjected to excessive temperatures, as it would be if set too close to the generator or carburettor; neither should the gas taken into it be of markedly different temperature than that of the solutions in the absorption bottles, and great care should be taken to remove all particles of scale and grease from the water supply pipe, as they are sure to block the aspirator and give endless trouble. If any trouble develops in starting the apparatus, the action of the aspirator is the most fruitful source of trouble.

The financial loss caused by an excess of carbonic acid in gas is considerable. It is very possible to operate with 3 per cent. of CO_2 in the carburetted gas; yet the output from many plants contains 5 per cent. or over. The difference in the cost of oil between the 3 per cent. and 5 per cent. on an output of 100,000,000 cubic feet, would be at least $1,000, and this amount is surely worth looking after. The writer believes that

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the amount of carbonic acid produced at any time is the best standard by which to judge what is taking place in the generator, both while "blowing up" the "heats," or making "blue gas," and that an indicator making this knowledge constantly available will be of great value to the industry.

Discussion.

The President: Gentlemen, this paper on a new carbonic acid gas indicator is now before you for discussion. Are there any remarks on this paper?

Mr. A. E. Forstall: Mr. President, it does not seem to me that Mr. Robison has made it quite clear as to whether the quarter-inch iron pipe he mentions in connection with the inlet of the carburetter is allow to remain open all the time, so that there is gas passing through it, both during the blow and during the run.

I would like to ask also if he has applied the indicator to the determination of the amount of carbonic acid in the flue gases from coal gas benches.

Mr. C. C. Tutwiler: While I do not quite understand from Mr. Robison's description of the indicator what may be the functions of several of the solutions employed, the principle underlying its operation is perfectly clear, and I see no reason why it should not be a very valuable instrument when placed in capable hands.

The fault with most of the CO_2 indicators which have come under my observation is their extreme liability to get out of order and thus furnish unreliable information. They require more or less constant attention by one who possesses not only facility for handling delicate apparatus, but also the ability and means to frequently check them up against the ordinary absorption method.

Instruments working on the "balance" principle, such as the "Arndt," while reliable when in good working order, are very susceptible to disturbing influences such as dust, etc. The Simmance-Abady Recorder and the "Ados" machine

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work on an entirely different principle, and while they are not so likely to get out of order, their first cost is high and the apparatus is complicated. What is needed is an apparatus as simple and reliable as a recording pressure gauge; one which will not be affected by rapid changes of temperature and which will stand a certain amount of rough handling. Mr. Robison has tried Prof. Jones' instrument in actual working practice, and his experience seems to indicate that a cheap and reliable instrument has been found.

Streche and Jahoda, of Vienna, have devised an apparatus working on the same principle which appears to be even simpler than Prof. Jones' apparatus; a description of this will be found in the Chemiker Zeitung, Volume 30, pages 1128 to 30.

I have no doubt that a final solution of the problem will be found in the adoption of this principle, the unequal tensions being registered on a Bristol or other recording gauge, thus getting a continuous record. I thoroughly agree with Mr. Robison as to the value of such an instrument, and it should go a long way towards insuring uniformity of results in water gas making, and by its aid carbonic acid could be kept down to a minimum.

It should also prove very useful in increasing boiler efficiency and in other situations where it is desirable to know the amount of CO_2 being made at any time.

THE PRESIDENT: Is there any further discussion of this subject?

MR. G. W. MCKEE: Mr. President, I would like to ask whether anyone has any information whether any attempt has been made to make this indicator work in connection with a chart of any kind?

THE PRESIDENT: Perhaps Mr. Robison can answer that as well as the other question.

MR. CHARLES D. ROBISON: In answer to the first question about allowing the pipe to be open at all times, I would say yes. I see no objection to that.

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While I have not had an opportunity to use the indicator on a coal gas setting, I have used it on water gas, and I find it very serviceable there. I see no reason why it should not be used on a coal gas bench.

A MEMBER: Mr. President, I think at the Atlantic City meeting of 1896, Mr. Holbrook read a paper on a CO_2 indicator, which I believe had a chart attached.

MR. MCKEE: I think, Mr. President, there was an apparatus of that kind which was used on the subway contract in New York. It is put up in a small room, about 6 ft. x 4 ft. x 8 ft., but it has much complicated glassware. It is not an apparatus which I think would be applicable for general adoption.

MR. GEORGE H. WARING: Mr. President, there is a statement in this paper which, to anyone not having experience in the manufacture of gas, is liable to be misleading. I refer to the last statement in the last paragraph of the paper in which it says that the difference in the cost of oil between the 3 per cent. and 5 per cent. carbonic acid, on an output of one hundred million cubic feet would be at least a thousand dollars. The inference would be that by reducing your carbonic acid from 5 per cent. to 3 per cent. you would save one cent per thousand cubic feet. There are a great many other conditions that might arise by trying to reduce your carbonic acid which would be more detrimental than to attempt to counteract the influence of carbonic acid. I wish to go on record as stating that in trying to reduce your carbonic acid too low, you are apt to get into other troubles that will be worse than having 5 per cent. of carbonic acid.

MR. ROLLIN NORRIS: Of course, Mr. President, the proportion of carbonic acid in both blue gas and blast gas in water gas manufacture varies very rapidly from moment to moment, and while an apparatus might be all right for indicating the percentage of acid when this percentage is fairly constant, it might not be practicable where, as in water gas

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manufacture, the variation is rapid. I would like to ask Mr. Robinson whether in applying this carbonic gas indicator to water gas sets the lag in the indication of the instrument has caused any trouble.

MR. A. G. GLASGOW: I think Mr. Waring and Mr. Norris have indicated the crux of this matter. For simplicity, let us consider *blue* water-gas manufacture. The consummations desired in the blast period and in the gas-making period are diametrically different. In the blast period, we want the products to escape without any CO present, whereas in the gas-making period we want the gas to issue without any CO_2 present. But it is impracticable to attain these opposite alternating conditions with the same fuel-bed, and it is found in practice that the best final result is attained when a considerable percentage of unreduced CO_2 is left in the crude gas. With gas-coke, the most economical proportion of CO_2 in the crude gas is seldom below an average of four per cent.; and this percentage usually varies from *nil*, in the beginning of each run, to over ten per cent. at the end of the run. Likewise, in the first instant of the blast period there is *no* CO present in the escaping blast products, whereas by the end of the blast period the proportion of CO has usually risen to over 15 per cent.; and the usual length of the blue water-gas blast period for gas-coke does not exceed one minute. Now, we have no reliable instruments that can concurrently indicate varying cycles like these, and any instantaneous indication which does not reveal the whole working cycle must be used with caution or its influence will be mischievous. On the other hand, an instrument giving reliable indication of the percentage of CO_2 present *at the last instant* of each run and blow will be serviceable, provided the influencing practical conditions are sufficiently considered to prevent a wrong diagnosis. Chief among these influences is the condition of the fuel-bed. For instance, blast-gas analyses may indicate high efficiency of working, when in reality the fuel-bed is so bad in parts that free oxygen is passing directly through the fire and producing secondary combustion on top of the fuel-bed. Also, the different condi-

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tions of the fire before and after clinkering must be kept in mind. In general, it is my experience that one must be exceedingly cautious in regulating operating conditions by instantaneous instead of average analyses.

THE PRESIDENT: Mr. Robison, will you close the discussion?

MR. CHARLES D. ROBISON: In regard to the sensitiveness with which the indicator works, I would say that it seemed to indicate very closely what would be expected in the operation of a water gas set. It lags a little at times behind what actually takes place, or what you would expect to take place, but we checked up the indications a great many times and found that the average was very close to what we got with the Orsat set, the difference being probably due to the difference in the samples taken, we being unable to get the samples simultaneously. As a general thing, the indications followed exceedingly close to what you would expect.

THE PRESIDENT: The next and last thing on the program is the report of the Committee on Pipe Standards.

Mr. Walton Forstall then presented the

REPORT OF COMMITTEE ON PIPE STANDARDS.

Purpose of Committee.

Your committee was appointed to consider the set of 34 plates, representing proposed standards for pipe and specials, which were presented at the 1906 meeting. These plates were practically identical with the standard adopted by the American Gas Light Association in 1905.

History of Work.

Letters inviting criticisms on these plates were sent to many foundries. Comparatively few replies were received. Neither did the members of the Institute avail themselves of the invitation given at the 1906 meeting, viz., that they should write for a set of the plates and forward any criticisms to the committee.

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A committee meeting was held in New York City, June 24, there being present Messrs. Strecker, Guldlin and Forstall. It soon became apparent that there was a decided difference of opinion regarding the plates under consideration. The chief objection advanced against them was that they required many separate patterns, whereas a standard could readily be designed along nearly the same lines, but which would allow of many interchangeable patterns. The committee decided to ask the foundries just how important to them was this question of interchangeability. It also delegated to one of the members the work of preparing amendments to the plates.

Only four replies were received to twenty letters sent to various foundries, and though their tenor favored interchangeable patterns, the few answers could not be regarded as a representative expression of opinion from manufacturers of pipe and specials. For this lack of interest, however, the committee is not to blame, and it has proceeded to make such changes in the plates as it thought were demanded by the interests of manufacturer and user alike.

A second meeting was held in Chicago on September 14th, there being present Messrs. Guldlin, Brown and Forstall. A third meeting was held in Washington, October 16th, there being present Messrs. Guldlin, Brown, Miller and Forstall. As a result of the three meetings and of correspondence between the various members of the committee, a set of 33 plates is herewith submitted.

In making any changes to the standard of the American Gas Light Association, it was recognized that, as such standard, it had been adopted by the largest pipe manufacturer in this country, and that patterns based on these plates were being made from day to day by many other foundries. In other words, the committee realized that no changes should be made except for very good reasons. On the other hand, in the belief that their work might find universal acceptance in due course of time, and therefore determine the design of gas pipe and specials in this country for a long time, the committee felt that there were certain changes that were urgently called for, notwithstanding these changes might involve some hardship

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in the loss of patterns and open the door to a charge of instability of purpose in the gas associations, on the part of those manufacturers who, after 1905, adopted the American Gas Light Association standard.

Explanation of Changes.

Having thus explained their attitude, the Committee now desire to describe in more or less detail the changes between the plates as now submitted to the Institute and as received by the Committee. These represented, as has been said before, the 1905 standard of the American Gas Light Association. For convenience of reference, they will be referred to as the "A" (Association) standard.

In the "A" standard, decimals were used throughout. So much objection has been made to this feature that all dimensions are now shown as fractions to the nearest thirty-second, except thickness of straight pipe, where decimals have been retained as necessary to express exactly the thickness corresponding to the weight.

The "A" standard was based on the idea that the same lineal dimensions of bell and spigot pipe were equally useful for street mains as for works (apparatus) connections. After considerable discussion, the committee has reached the conclusion that the needs for street work are rather different than for works connections. Therefore, the term "street" has been applied to those plates designed with reference to street main requirements, while the specials adapted for works use are indicated on separate plates, flanged and bell and spigot specials being shown on the same plate, and being of such dimensions as to be interchangeable.

Considering now each plate in turn (numbers are those of present plates):

Plate 1. Standard Bell and Spigot Pipe: No change.

Plate 2. Street Quarter Bends, Class "A": No change.

Plate 3. Street Quarter Bends, Class "C": No change.

Plate 4. Street Eighth Bends, Class "A": Extended to 48 in.

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Plate 5. Street Eighth Bends, Class "B": Dimension "I" increased about 2 in. to make certain dimensions correspond to similar ones on Plate 8.

Plate 6. Street Eighth Bends, Class "C": No change.

Plate 7. Street Sixteenth Bends, Class "A": Extended to 48 in. Dimensions "I" changed a fraction of an inch to make certain dimensions correspond to similar ones on Plate 4.

Plate 8. Street Sixteenth Bends, Class "B": No change.

Plate 9. Street Sixteenth Bends, Class "C": No change.

Plate 10. Bushings: No change.

Plate 11. Caps: Centre lugs omitted. Extension of use of side lugs.

Plates 12 and 13. Street Crosses and Tees: No change.

Plate 14. Line drips: No change.

Plate 15. Yard and Holder Drips: No change.

Plate 16. Hat Flanges: 20 in. sizes added. Dimension "N" changed to even inches.

Plate 17. Plugs: No change.

Plate 18. Drip Plugs: No change.

Plate 19. Reducers, Class "A": Dimensions "H" and "I" changed where necessary to make slope constant for all sizes of reducers. Dimension "J" changed where necessary to make it constant for the same sizes.

Plate 20. Reducers, Class "B": Dimensions "H," "I," "J" and "K" changed to agree with corresponding dimensions in Plate 19.

Plate 21. Reducers, Class "C": Same changes as to Plate 20.

Plate 22. Concentric Reducers: 16 in. and 20 in. sizes added. Dimensions "H", "I", "J" and "K" changed to agree with corresponding dimensions in Plate 19.

Plate 23. Split Sleeves: No change, except "D" made about ⅜ inch smaller.

Plate 24. Hub Sleeves: Same change as Plate 23.

Plate 25. Service Sleeves: Same change as Plate 23.

Plate 26. Solid Sleeves: No change.

Plate 27. Y-Branches: Dimension "J" (now "H") changed to agree with corresponding dimension on Plate 5 and (old) Dimension "H" changed to equal "I".

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Plate 28. Flanged Straight Pipe: Outside diameter of 8 inch flange changed to 13 in. and of 12 in. flange to 18 in. to agree with 1898 standard of American Gas Light Association.

Plate 29. Flanged Quarter Bends (with or without base or handhole): Dimension "H" changed to be more consistent as between various sizes, and decreased 2 in. for 36 in. and 1 in. for 42 in. specials. Design of handhole modified and dimension of base decreased.

Plate 30. Flanged Eighth Bends: No change except "R" extended to show radius of centre line.

Plate 31. Flanged Crosses: Changes similar to those made on Plate 29.

Plate 32. Flanged Tees: Changes similar to those made to Plate 29.

Plate 33. Flanged Reducers: Changed to make taper uniform, and "J" and "K" similar to plate 19.

On several of the plates of flanged specials, no weights are shown because there has not been time enough to calculate these weights accurately since the last changes were made. Careful calculation will, however, be made, and the proper weights inserted in the tables before they are printed in the Proceedings.

Recommendation.

The Committee recommends that these plates be adopted as the standard of the Institute, and that, either by means of a separate committee or through the agency of any permanent committee that may be appointed to advance technical work, active measures be taken to procure the rapid adoption of this standard, by urging the members to specify it in their orders, and by persuading the manufacturers to change their patterns as fast as possible. In past years, standards have been adopted at meetings of gas associations, and then, with few exceptions, the members promptly forgot the standard and specified or took other patterns. This failure to put into practice the designs voted for without dissent, undoubtedly explains the indifference of the manufacturers to any proposed standard.

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They believe, judging the future by the past, that any standard that we may adopt will not affect their practice to any appreciable extent. Your Committee hopes the Institute will redeem the reputation of the gas profession in this regard, and it earnestly desires a full discussion on the plates. Every member who votes for the proposed standard, and yet does not intend to use it in his work, because of his preference for what he is now using, owes it to the Institute to explain his position now and fully.

R. B. BROWN,
O. N. GULDLIN,
THOS. D. MILLER,
WALTON FORSTALL.

[NOTE.—Owing to the fact that the matter of Pipe Standards was referred to the Technical Committee for further consideration (see later in the Proceedings) it was not deemed advisable to publish at this time the thirty-three plates referred to in the above report.]

MR. WALTON FORSTALL: I will also read a letter from Mr. Strecker, in which he disagrees with the report just read, and his letter is to be considered as a minority report.

PUBLIC SERVICE CORPORATION OF NEW JERSEY.

GAS DEPARTMENT.

NEWARK, N. J., Oct. 12, 1907.

Mr. Walton Forstall,
Chairman, Committee on Pipe Standards,
U. G. I. Building, Philadelphia, Pa.

Dear Sir: Your favor of the 5th inst. has come. I am also in receipt of draft of minutes of meeting of this Committee in Chicago and of proposed report to the American Gas Institute.

I am afraid that I shall not be able to attend the meeting of the Committee called for Tuesday evening next, at Washington. I have, however, carefully read the proposed report and gone over the amended set of plates.

I very much regret that, as the matter now stands, I cannot join in signing the report and in recommending the acceptance of the plates as the standard of the Gas Institute.

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I have always been strongly of the opinion that any standard like the proposed one, worthy of the name, should be based upon certain fundamental principles. Foremost among these, according to my views, is the constancy, for each size of pipe, of the dimension H (as used in the plates), denoting the distance between centre line of special casting and face of flange or back of bell, as the case may be. Having this dimension a fixed one, castings will be interchangeable, pattern work will be reduced to a minimum and the laying out of work will be made easy.

When we met in New York in June last, I found Mr. Guldlin very strongly of the same opinion. I also gathered from letters read, that Mr. Brown had a decided leaning that way. However, the result of the Chicago conference appears to have been a compromise, which practically sets up two distinct standards within the frame of your proposition, one of so-called Street Specials, the other for Castings to be used at the Works. The Street Specials section of the Standard splits again into two, as far as the value H is concerned, one for tees and crosses, another for 90 degree bends. We have thus for each size of pipe three different values of dimension H, to wit, one for Works Specials (both bends, crosses and tees, bell and flange ends) another for Street crosses and tees, and a third one for 90 degree bell bends.

I fail to see why a distinction should be made as between "Works" and "Street" Specials. These castings should be all of the same pattern and could be used and are used indiscriminately in the Works or in the Street Department. Whichever value of dimension H would suit the views of the majority of the members, should have been adopted for all classes of castings.

Taking up the plates seriatim would make the following remarks:

Plate 1. Bells and Spigots. Agreeable to me.

Plates 2 and 3. 90 degree Bends. Come under general criticism as to value of "H."

Plate 4. 45 degree Bends. Would advocate making dis-

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tance "H" the same for both 45 degree and 22½ degree bends (shown on Plate 7).

Plates 5 and 6. These patterns are hardly needed.

Plate 7. Same remarks as to Plate 4.

Plates 8 and 9. Patterns hardly needed.

Plate 10. Bushings. These bushings, as I take it, are to act as short reducers. They are to be inserted like plugs into bells of fittings and in turn form other bells to receive spigots of pipes of reduced diameter. The plug part of the bushing should be the same as the ordinary plug, but in the proposed pattern it is not. The latter is from 4½ to 5 inches long with taper of ¼ inch, which is barely sufficient. The regular plug pattern is 5¼ inches to 6 inches long with taper of only ⅛ inch. Then as to the bell part of the bushing, this should have exactly the same dimensions as a regular bell, and this has been followed out, except that it has no shoulder to receive the spigot of the entering pipe, especially if this should have no bead, as in a cut pipe. In the instance for example of a 6 x 4 bushing, the back of the bell is reduced to $5\,^{3}/_{16}$ inches diameter only, which is exactly the size of a 4 inch spigot including bead. This would thus possibly, and a cut pipe would surely, slip through the opening, which is certainly not what it should be.

Plate 11. Caps. No objections. Rarely used in modern work.

Plates 12 and 13. Crosses and tees. Open to the general objection as to value of "H."

Plate 14. Street drips. It is hard to conceive why the bodies of these drips are made at a slight variance from regular pipe sizes like 12⅛ inches, $15^{31}/_{32}$ inches, $19^{31}/_{32}$ inches, etc. Why not make them of regular pipe size, 12 inches, 16 inches, 20 inches, etc., provided with a standard bell and closed with a standard plug? The bulk of the patterns have a fairly even depth below the bottom of the run of pipe with the notable exception of the 4 inch drip, which is entirely too shallow, measures only 13 inches below outlets and holds only about six gallons of water.

Plate 15. Yard and Holder drips. No objections beyond

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what is stated as to Plate 14. Local considerations will often call for variations from this standard.

Plate 16. Hat flanges. No objections.

Plate 17. Plugs. I consider this pattern a poor one. There is no call for the curvature in the cover. Cover should join the sides at the upper edge, so that plug is particularly strong at this juncture and not unsupported and weak as in pattern shown. The taper given, only ⅛ inch, is so small as not to be of practical value and the plug cannot be backed out. The lugs shown are of little help in this work. Length and taper of plugs should be like that of bushings.

Plate 18. Drip plugs. Should be of same patterns as regular plugs and not varying from same as to length as shown on plate. Even the street and the yard drip plugs are made to vary in this respect.

Plates 19 to 22. Reducers. Am glad to note that reducer patterns now show an even rise for all sizes.

Plates 23, 24, 25. Split, hub and tapped sleeves. Would advocate ribs on lower flanges, to hold heads of bolts in position, when bolting up, same as on wrought iron pipe flanges. Object to provision calling for "machining" faces of flanges, since it adds largely to the cost and is unnecessary, since sleeves are usually put on with cement, which material will also make a satisfactory joint between the two halves of sleeves, without their being faced.

Plate 26. Sleeves. No objections.

Plate 27. Y branches. No objections.

Plates 29 to 32. Flange and bell fittings for use at Works. Open to general objection as to the value of dimension "H".

Plate 33. Flange reducers. No objections.

In conclusion would say, that while I appreciate that some patterns have been made based upon the standard adopted two years ago, of which the proposed one is largely a reproduction, and that any change from this standard would be somewhat of a hardship on foundries having done so, yet they would not be hit any harder than others that have proceeded along the lines of the '98 or any other standard.

As you have stated, this question should be settled for a

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long time to come and therefore we should settle it in a proper manner and worthy of the talent represented by the Gas Institute. It will appear to any Engineer who will carefully study the matter that the proposition before us is not the best that could be gotten up, but rather a compromise of existing patterns, of differences in opinion and of interests.

And while much time has already been spent over this vexed question, I would prefer to have its final disposition laid over for another year to having something adopted which falls short of the work and will thus never become popular and lasting.

Yours truly,

A. H. STRECKER.

DISCUSSION.

MR. E. E. WITHERBY: I think the Committee shows very plainly here that the representatives of the manufacturers took a very great interest in this matter. As I remember it, there was a report adopted by the American Association in 1898, another in 1901, and another report was adopted in 1905. It was adopted and passed, probably unanimously, by the Association, at that time, like a great many other reports. Like many other reports, it was probably read by the committee, and the members thought if the committee approved it unanimously it must be a good thing and it was adopted. We know that is the way with a good many reports, and then they are forgotten just that quick. Now the constant change of the standard is something for which the Gas Association has been in a measure responsible, and is opposed to that idea of unity of purpose that we would all like to see. The 1901 standard was in use for quite a long time. It has been considered good and very few have had any trouble with it. It apparently satisfied everybody, and I rather object to this constant bringing of the matter up for every little change here or little change there. No rule that anyone will accept will probably fit all conditions.

MR. WALTON FORSTALL: Mr. President, before this discussion goes any further, I might say to Mr. Witherby that there was no standard adopted in 1901, but the American Gas

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Light Association was trying to establish the '98 standard, and I sent in an extended criticism upon it. Now as to the 1905 standard, personally I would like to see it adopted by the Institute in the form it took after revision. The 1905 standard was designed by a pipe manufacturer along the lines wanted by certain large users of pipe, but unfortunately in working out the details there were so many errors made that all the plates had to be gone over and revised. That work of revision was done by The United Gas Improvement Company, and it was done in time to have the manufacturer get the revised standards into his catalogue. Because the 1905 standard, as adopted by the American Gas Light Association did not exactly agree with the standard desired, we, who were interested in the task, could not come before the Institute in 1906, and say, "Please take the standard of 1905, the standard of the American Gas Light Association, because it is a good standard," but we had to say that the plates we had prepared represented practically the same standard as that adopted in 1905. As stated in our report, the plates that are now up for consideration represent a compromise.

MR. A. S. MILLER: Mr. President, in the first place, I would like to say something about the adoption of the standard in 1905. Unfortunately, I was not at that meeting as I should have been. In '98, or previous to '98, the question was put to the Research Committee of the American Gas Light Association whether or not the standard of the Society of Gas Lighting which had been in use for a great many years should be adopted. A great many foundries and companies had patterns based on the standard of the Society of Gas Lighting. After going through the subject very carefully, and after having the Society of Gas Lighting correct some small dimensions which did not change the general dimensions of the casting, the American Gas Light Association adopted that standard. The point was made that the standard was incomplete, and it was referred to a committee, as I understood at the time, to elaborate it. The question was taken up with the largest pipe manufacturers in the country, and after an interview with their

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representatives, the understanding was reached that with the exception of certain flange castings which were to be shortened, the general dimensions of the street castings were to remain as the dimensions of the American Gas Light Association standard. The next I heard of it, this question came up at the last minute of the meeting of the American Gas Light Association in Milwaukee. The President of the Association said the report of the Committee was all right, and the report was adopted, practically without consideration. Now there have been a great many changes in the dimensions which will practically destroy the value of the patterns made by those parties who have followed the standard of the American Gas Light Association, which was adopted after a great deal of thought, and which could be elaborated. What is going to be the effect of this aside from the effect on the mind of the people whom we ask to make patterns? Take the $^1/_{16}$ bends for instance; the 4 inch weighs, under the proposed standard, 58 pounds, and under the '98 standard, 44 pounds; the 6 inch, under the '98 standard, weighs 64 pounds, and under the proposed standard, 91 pounds; the 8 inch, under the '98 standard, weighs 100 pounds and under the proposed standard 130 pounds.

Coming down to crosses, the 4 inch cross under the proposed standard, 143 pounds; under the '98 standard, 97 pounds. 6 x 4, proposed standard, 173; actual weight, old standard. 122. 8 x 4 crosses, under the proposed standard, 230; actual weight, old standard, 179. 8 x 6 crosses, proposed standard, 262; actual weight, old standard, 186.

Four inch tee, proposed standard, 108; old standard, 71 pounds. 6 x 4 tee, 143 pounds; old standard, 110 pounds. 8 x 4, new standard, 195; old standard, 159.

I would, therefore, suggest that if changes are to be made it should be done with a view to saving money. The principal dimensions of the old American Gas Light Association standard should be retained as far as possible and such minor changes should be made as experience has proved to be necessary.

I do not know whether any of the members of the Association have had much difficulty with the breaking of hubs. In five years but three hubs have been found broken in the city

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of Baltimore and all of these were defective. In at least one city, I understand, there has been considerable breakage of the old American Gas Light Association hubs, and in connection with any revision of the standard this should be considered. On the whole, the standard should specify castings as light as is consistent with safety and durability.

MR. E. E. WITHERBY: Mr. President, I would move that this matter be referred to the proper committee under the new constitution.

MR. WALTER WOOD: Mr. President, may I suggest an amendment to the motion; that the Technical Committee be requested to meet with the Cast Iron Pipe Manufacturers before coming to any definite conclusions.

After the receipt of the letter of your Committee last summer, the Cast Iron Pipe Manufacturers had a meeting, at which from 80 to 85 per cent. of the tonnage made was represented.

They asked your Committee for a joint session so that all these questions of detail could be discussed, and some satisfactory standard to all concerned settled upon. I think my amendment has some appropriateness, and I hope it will be duly seconded.

There is another reason why it is very desirable to have the thing carefully worked out now, and especially for the future, it is this: the manufacture of pipe, in the past, has been largely hand work. It is now becoming very rapidly automatic machine work, therefore in preparing the tools for flanges and moulding machines for special sizes it is exceedingly desirable for the manufacturers and the customers to come to a common understanding.

Speaking for the manufacturers, I think that their feeling is this: that no one set of ideas should undertake to dominate the situation. The manufacturers wish to progress, and they wish to prepare a line of tools which shall be satisfactory to their customers. No manufacturer that I know of desires to throw anything in the way of progress, or is inclined to insist upon progress along their own lines. They do not regret

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any money that may have been spent in old patterns. In other words, the way to progress is to adopt the proper course based upon a thorough and careful study of the conditions, therefore, I hope before anything final is concluded that my suggestion will be accepted. I should therefore suggest as an amendment, Mr. President, that the Technical Committee be authorized and instructed to ask for a joint session with the Cast Iron Pipe Manufacturers' representatives.

MR. E. E. WITHERBY: Mr. President, I hope that Mr. Wood will withdraw that amendment. I think when he comes to look at the personnel of the Technical Committee of this Institute as it now stands, he will realize that there is no necessity of such an amendment, and that when this committee comes to a mature determination of what is best to be done, I think he will be satisfied with the result.

MR. WALTER WOOD: I should be very glad, Mr. President, to simplify the discussion by withdrawing my suggestion. I think the importance of it, however, is this: There has been a great deal of discussion about standards, and to simplify and shorten our time here, I want to illustrate what is in my mind by this one fact. The American Society for Testing Materials has adopted a series of weights and thicknesses for straight pipe. Except in a very few instances they meet almost exactly the classification that has been adopted by the Gas Institute, where the table that this Institute has prepared varies from $^{1}/_{100}$ to $^{2}/_{100}$ of an inch. It seems to me hardly worth while for such small differences to be made permanent. It seems to me we ought to try to find a common ground and clear away these minute differences. It is very desirable to be done. That is the reason of the request that the pipe manufacturers made of your committee, viz., that we should have a meeting and eliminate these small differences.

THE PRESIDENT: Then I understand, Mr. Wood, you do not withdraw your amendment. The amendment is in order if you insist upon it, but I think that Mr. Witherby's idea is the

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correct one, that the committee certainly will not decide this question without consulting with the pipe men, and therefore the amendment is hardly necessary.

MR. E. E. WITHERBY: That is it exactly, Mr. President. I do not think it is necessary to even consider such an amendment, for with a committee made up as the Technical Committee of this Institute is now made up, all of those matters will be sufficiently safeguarded.

MR. WALTER WOOD: Mr. President, if it is the understanding that such a course will be taken, it is as good as a motion to that effect. The only thing that I want is that united action be taken and a free discussion had so that these differences can be cleared away. I take it then that the letter which the Cast Iron Pipe meeting addressed to the Committee will be accepted, and our Committee asked to meet them. If that is the understanding, why, that is as good as the amendment, and I am perfectly satisfied with an agreement of that kind, and with that understanding I will withdraw the amendment, if the gentleman wishes it done.

MR. E. G. COWDERY: Mr. President, it does not seem to me that we want any understanding or agreement, and I would suggest that if Mr. Wood wishes to bring this up that he put it in the form of a suggestion, that the Committee, or Sub-Committee, be authorized to hold such a conference, but we should not give that Committee specific instructions as to what it is to do. The motion was to place specific instructions that it must do so and so, and that does not seem to me to be quite in order. To my mind, it will serve every purpose if we simply authorize the Committee to take such action in that line as may be in accordance with its plan of proceeding when it comes to lay it out.

THE PRESIDENT: Mr. Witherby, let me make a suggestion? Will you make some slight alteration in your motion so as to cover what Mr. Wood desires?

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MR. E. E. WITHERBY: Mr. President, I think the original motion covers it fully; that this matter, instead of being cleared up now, as some people would like, that the matter be referred to the Technical Committee of the Institute for their consideration. I think that is proper enough and covers it all—all that is necessary to include in it. I am perfectly willing, if I have any personal interest in the matter, to leave it to the Committee. I will abide by their judgment.

A MEMBER: Mr. President, I rise to a point of information. Was Mr. Wood's amendment seconded.

THE PRESIDENT: Mr. Wood's amendment was seconded.

Mr. Wood's amendment to Mr. Witherby's motion is to the effect that the Technical Committee be requested in the course of the preparation of their report to this Institute on pipe standards to consult or confer with the manufacturers of pipe.

MR. WALTER WOOD: It seems to me, Mr. President, that there is a little misunderstanding, and I think it would be well for the Committee to understand exactly who those were who made that request. That request came from some of the largest pipe manufacturers in the United States, and, as I said before, representing from 80 to 85 per cent. of the tonnage of cast iron pipe manufactured.

MR. PAUL THOMPSON: Mr. President, let me suggest to Mr. Wood that if he would change the wording of his amendment by putting it in the form of a suggestion, or request, that the Committee take such action, it would be in better form to pass it.

MR. WALTER WOOD: I am perfectly willing to do that.

THE PRESIDENT: Mr. Wood changes his amendment then by substituting the word "suggest" for the word "request" or "instruct." Will that be acceptable to the seconder of Mr. Wood's amendment?

MR. DONALD MCDONALD (Louisville): It is satisfactory to me, Mr. President.

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THE PRESIDENT: The seconder also accepts the amendment.

MR. WALTON FORSTALL: Naturally I am quite familiar with the work of the Pipe Standards Committee. As the report states, we tried to get the opinion of the pipe manufacturers. We did not reply to the specific invitation extended by Mr. Wood. This invitation came as from Mr. Wood and two other pipe manufacturers. One of them was the United States Cast Iron Pipe & Foundry Co., and it represented certainly two-thirds of the 85 per cent. spoken of by Mr. Wood. On the receipt of Mr. Wood's invitation, I communicated with a Vice-President of the United States Cast Iron Pipe & Foundry Co., and received by wire and letter a statement to the effect that his company disavowed any authority on Mr. Wood's part to speak for them, and that his company was in accord with the plates embodied in our report. These facts I in turn communicated to Mr. Wood.

I think the Institute is very wise if the members are not sure they desire to accept our report, to refer the whole matter to the Technical Committee. The Sub-Committee that will be appointed to look after this question of pipe standards will soon discover how difficult a task it is. They will discover that the 1898 standard, as talked of by some of its advocates, is not the 1898 standard as shown in the Proceedings of the American Gas Light Association, but a modified standard, which has never been communicated to the records of any association. We will await the result of their labor with much interest.

MR. E. E. WITHERBY: Mr. President, it seems to me that the history of these different standards during the past few years is a very good criterion to judge by in this case. It is a matter which needs further study and investigation. I would like to see something done, and I would like to get to the end as soon as possible. All that any of us want to see, I think, is that no direct or positive instructions should be given to this Committee at this time. As the gentleman has just said, it is a Committee which ought to command the entire confidence of the Institute. I wish you would all read the names.

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THE PRESIDENT: There are no instructions involved in Mr. Wood's amendment as it now stands.

MR. DONALD MCDONALD: Mr. President, in seconding that amendment again, I feel just as I did when I first seconded it, that we do not want to make any arbitrary changes and force a change in the patterns unnecessarily. I think it is a matter that can be decided by letting both sides express their views fully. I think that we appreciate the situation of the manufacturers, and that the members of this body want to meet them in a reasonable way, and to agree on a standard that we recommend, it will be that much more desirable, and will have a much more binding effect upon everybody, and therefore much more liable to be adopted.

THE PRESIDENT: The question is on Mr. Wood's amendment as seconded by Mr. McDonald. Those in favor will please say "Aye." Contrary minds, "No." It is carried.

The question is now on Mr. Witherby's motion as amended, that the whole matter be referred to the Technical Committee, with the suggestion that in coming to their conclusions and before reporting to the Institute that they confer with the pipe manufacturers. Are you ready for the question? Those in favor please say "Aye." Contrary minds, "No." It is carried.

THE PRESIDENT: Are there any nominations for Secretary-Treasurer?

The following nomination was presented:

"We, the undersigned members of the American Gas Institute, nominate James W. Dunbar as Secretary-Treasurer, in accordance with the recommendations of the Board of Directors:

A. C. Humphreys,	L. D. Spragle,
A. S. Miller,	W. C. Morris,
Donald McDonald,	G. W. Clabaugh,
F. N. Morton,	E. G. Pratt,
Carroll Miller,	Paul Thompson,
W. O. Lamson, Jr.,	J. J. Humphreys,
Geo. Waring,	W. Forstall,
A. G. Glasgow,	A. E. Forstall,
E. H. Earnshaw,	W. H. Gartley,
A. D. Whittaker,	Geo. Old,

Special Nominating Committee.

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THE PRESIDENT: Gentlemen, you have heard the nomination of Mr. Dunbar for Secretary-Treasurer by this Committee. I presume that is in accordance with the previous understanding. All in favor of the election of Mr. Dunbar, please say "Aye." Contrary minds, "No." It is unanimous.

MR. E. E. WITHERBY: Mr. President, while there is a fair representation present, I would like to make a motion. I do not believe in deferring the matter too long. There has been a lot of hard work done here by the Committee having charge of the local arrangements, and I move that a vote of thanks be extended to the Committee for the very able manner in which they have handled the arrangements.

Motion seconded.

THE PRESIDENT: Gentlemen, you have heard the motion. It is a motion of thanks to the Committee on Arrangements. Those in favor please say "Aye." Contrary minds, "No." It is unanimously passed.

MR. PAUL THOMPSON: Mr. President, it occurred to me that there are perhaps some committees which have not reported, and as under the change in the Constitution which has been made all of these matters will have to be referred to the Publication Committee, it seems to me it would be a good idea to pass a vote referring anything that may be in existence in the committees to that Committee. I therefore move, Mr. President, that any committee not reporting be discharged from any further consideration of the subject referred to them.

Motion seconded.

THE PRESIDENT: Those in favor please say "Aye." Contrary minds, "No." It is passed.

Is there any further business to come before the Institute? Gentleman, before we adjourn, let me say that there are many things that it seems to me we have reason to congratulate ourselves upon, but especially it seems to me that we come to the

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end of a rather strenuous meeting with mutual respect and loyalty, and that we should go from here with a mutual determination to make this Institute a success, or, as I said in my address, the leading light among scientific men devoted to the advancement of the Gas Institute.

If there is no further business I will declare the Institute adjourned *sine die*.

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PROCEEDINGS

OF THE

AMERICAN GAS INSTITUTE

SECOND ANNUAL MEETING

1907.

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In Memoriam.

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ARTHUR C. PEASE
Lowell, Mass.
Died January 3d, 1907

JAMES B. CAHOON
New York, N. Y.
Died February 16th, 1907

JAMES R. BOWEN
Schuylkill Haven, Pa.
Died March 19th, 1907

JOHN O. JOHNSTON
Columbus, Ohio.
Died April 21st, 1907

THOMAS B. RITER
Pittsburg, Pa.
Died April 23d, 1907

JOHN S. WILBRAHAM
Philadelphia, Pa.
Died July 2d, 1907

AUGUSTINE S. MALLORY
New York, N. Y.
Died August 9th, 1907

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ARTHUR CHAPIN PEASE.

BORN February 21, 1865. DIED January 3, 1907.

Arthur Chapin Pease was born February 21, 1865, at Fulton, Ill. He graduated from the Civil Engineering course at Yale in 1891, returning for a Post Graduate course which he completed in 1893. During 1892 he was employed as Assistant Division Engineer of the Chicago & Alton Railroad.

He started in the gas business with the New York & East River Gas Company in 1895, being actively engaged in the construction work of that Company, including the notable achievement of driving the tunnel under the East River from Sixty-third Street, New York City, to Ravenswood, L. I. Gas has been conveyed to Manhattan through this tunnel for a number of years. Subsequently Mr. Pease became connected with the American Gas Company of Philadelphia, having charge of the Mt. Vernon plant, and remaining with the United Gas Improvement Company after that Company's purchase of this property. In 1902 he was appointed to the responsible position of Superintendent of the United Gas Improvement Company's plant at Yonkers, N. Y., where he remained until 1904, when he accepted the call of the Lowell (Mass.) Gas Light Company. Under his direction as Superintendent, the modern plant at Lowell was developed and he here established new records of cost of operation of a coal gas plant.

He was elected an active member of the American Gas Light Association in 1903, of the Western Gas Association in 1905, and became a charter active member of the American Gas Institute.

He was also a member of the Guild of Gas Managers and of the New England Association of Gas Engineers.

Mr. Pease was of a quiet, retiring nature, but very forceful and persevering in his work and he accomplished much. As to his Company's estimate of his worth and a personal tribute, the following is quoted from a letter of the President: "I never could wish to be associated in business with a finer man than Mr. Pease. He was entirely satisfactory in every way, and, if he had lived, I think he would have gone far as a gas engineer."

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JAMES BLAKE CAHOON.

BORN December 22, 1856. DIED February 16, 1907.

James Blake Cahoon was born December 22, 1856. At the age of 22 he graduated from the United States Naval Academy at Annapolis and entered service on the U. S. S. "Vandalia." He took part in the Transit-of-Venus expedition in Patagonia in 1882, having been transferred from the "Vandalia" to the U. S. S. "Brooklyn," with which ship he served until 1884.

Lieutenant Cahoon graduated from the United States Torpedo School in 1885 and was one of the few selected to take the post graduate course in electricity. While experimenting with searchlights, he was so unfortunate as to seriously impair the sight of one eye, and this finally led to his retirement from the service in 1889.

The five following years he was connected with the Thompson-Houston Electric Company and the General Electric Company in various responsible positions, leaving the latter Company in 1895 to take up the general managership of the Electric, Gas, Water and Street Railway Companies of Elmira, N. Y. Several years later, Mr. Cahoon established himself as a consulting engineer, and, at the time of his death, was Vice-President and Chief Engineer of the Eldenbel Construction Company of New York City.

He was a member of the American Society of Mechanical Engineers; the American Institute of Electrical Engineers; the Military Order of Foreign Wars and the Geographical Society. He was a Son of the American Revolution and a veteran of the Spanish-American war.

Mr. Cahoon was at one time President of the National Electric Light Association. His life work was more closely identified with the electrical than with the gas business.

He became a member of the Ohio Gas Light Association in 1905 and a charter member of the American Gas Institute upon its formation.

It is with much regret that his death is recorded so shortly after his connection with Gas Association work.

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JAMES ROGAN BOWEN.

BORN February 19, 1868. DIED March 19, 1907.

James Rogan Bowen was born in Pottsville, Pa., February 19, 1868. He received his early education in the public schools and supplemented this later in life by taking a course with the International Correspondence Schools of Lighting and Mechanical Drawing.

He became a member of the Ohio Gas Light Association in 1905 and a charter active member of the American Gas Institute the following year.

Mr. Bowen was for some time identified with the Pottsville Gas Company, Pottsville, Pa., and at the time of his death, which occurred on March 19, 1907, he was Superintendent of the Schuylkill Haven Gas & Water Company, Schuylkill, Pa.

JOHN ORSON JOHNSTON.

BORN May 17, 1853. DIED April 21, 1907.

John Orson Johnston was born in Allegany County, N. Y. After receiving a common school education, he was engaged in mercantile business until 1877, when he became interested in oil operations in Pennsylvania and later in the Lima, Ohio, oil field. He went to Columbus and was one of the organizers of the Central Ohio Natural Gas & Fuel Company in 1889; continuing with that Company and interests with which it was consolidated until the time of his death. He was Superintendent of the Central Ohio Natural Gas & Fuel Company; President and General Manager of the Columbus Gas Light & Heating Company; President and General Manager of the Columbus Gas & Fuel Company. He was also Vice-President and General Manager of the Deschutes Irrigation & Power Company, and one of its organizers.

He was an active member of the Ohio Gas Light Association, of the Western Gas Association, and a charter member of the American Gas Institute.

Mr. Johnston died in the prime of life after a long illness.

The following is quoted from the letter of a business associate: "He was of revolutionary stock, a man of sterling character, able, and of a genial disposition that endeared him to those with whom he came in contact."

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THOMAS B. RITER.

BORN December 22, 1840. DIED April 23, 1907.

Thomas B. Riter was born on December 22, 1840, in York, Pa. After receiving his education in his native city, he became identified with the iron trade, and, when about twenty years of age, removed to Pittsburg, where he shortly entered the employ of the firm of Riter & Conley, of which his brother was the senior member.

Upon the death of his brother in 1873, he became a member of the firm. Shortly after the death of Mr. Conley in 1897, the concern was incorporated under the name of the Riter-Conley Manufacturing Company, with Mr. Riter at its head, and to his skilful planning and guidance, his untiring devotion and his splendid personality, this well-known Company largely owes its wonderful growth and success.

He was elected an associate member of the American Gas Light Association in 1904, and became a charter associate member of the American Gas Institute upon its formation.

About three years ago, Mr. Riter's health failed somewhat, and, subsequently, the sudden death of his only daughter resulted in a shock from which he never recovered.

He died on April 23, 1907.

In the language of a testimonial to his memory: "Resolute, skilful, untiring and lovable, Mr. Riter's death will be mourned by many with whom he labored, assisted and associated."

JOHN S. WILBRAHAM.

BORN January, 1860. DIED July 2, 1907.

John S. Wilbraham was born in Philadelphia and received his education in the public schools of that city. At the early age of fifteen years, he entered the office of Wilbraham Brothers, becoming Secretary and Treasurer in 1889, and retaining this position with the firm and their successors, the Wilbraham-Baker Blower Company and the Wilbraham-Green Blower Company until the time of his death.

In this connection, extending over a period of thirty-two years, he was well known in the gas business.

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Mr. Wilbraham became an associate member of the American Gas Light Association at the 1892 meeting and was a charter associate member of the American Gas Institute.

He was also a member of the Franklin Institute, the Manufacturers Club of Philadelphia, the Trades League of Philadelphia, and the Society of St. George.

Mr. Wilbraham went abroad in hopes of recovering his health, but died in Edinburgh, Scotland, July 2, 1907.

AUGUSTINE SHEPPARD MALLORY.

BORN April 27, 1871. DIED August 9, 1907.

Augustine Sheppard Mallory was born in Franklinton, N. C., April 27, 1871.

He obtained an education at the Virginia Polytechnic Institute, but acquired most of his engineering knowledge through actual experience and self-instruction, being in the truest sense of the word a self-made man.

At an early age he entered the employ of Messrs. Leddell & Co., of Charlotte, N. C. In 1891 he removed to Philadelphia and shortly thereafter entered the service of R. D. Wood & Company as field engineer, later becoming connected with the engineering staff of the N. Y. Mutual Gas Light Company. In 1903 he became Superintendent of Construction and Resident Engineer with Bartlett, Hayward & Company, in which capacity he was serving at the time of his death.

Mr. Mallory joined the American Gas Light Association in 1904 and was a charter associate member of the American Gas Institute. He was also a member of the Illuminating Engineering Society and of the Royal Arcanum.

Mr. Mallory died at his home in Brooklyn, August 9, 1907. Taken in the prime of life when beginning to reap the rewards of his constant devotion to his profession, he leaves many friends throughout the gas fraternity.

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CURRENT GAS LITERATURE.

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[NOTE: The Institute is under obligation to the United Gas Improvement Company of Philadelphia, for furnishing the data from which this list is prepared.]

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CONSTITUTION AND BY-LAWS

OF THE

American Gas Institute

CONSTITUTION.

(As Amended October 16, 1907.)

NAME.

SECTION 1. The name of this association shall be the AMERICAN GAS INSTITUTE.

OBJECTS.

SECTION 2. The objects of this Institute are to amalgamate into one body the American Gas Light Association, the Ohio Gas Light Association, and the Western Gas Association, and to facilitate co-operation between the various state and district associations that now exist, or may hereafter be formed within the territory covered, and to secure thereby the more rapid promotion and advancement of scientific and practical knowledge in all matters relating to the construction and management of gas works and the manufacture, distribution and consumption of gas; the firmer establishment and maintenance of a spirit of fraternity between those interested in the gas business by affording opportunity for social intercourse and friendly interchange of information and ideas; the inducement and extension of more cordial and friendly relations between gas companies and consumers of gas based upon their mutual interests, and the education of employees of gas companies to enable them to better perform their duties. Also to take over such property and assets of the associations named as may be legally invested in the Institute.

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MEMBERS.

SECTION 3. The membership of the Institute shall consist of Honorary Members, Active Members, Junior Members and Associate Members. Honorary Members, Junior Members and Associate Members shall not be entitled to vote nor to hold office, but shall be entitled to all the other privileges of membership.

SECTION 4. Honorary Members shall be persons whose scientific or practical knowledge in matters relating to the gas industry, and whose efforts and interest in that behalf shall recommend them to the Institute.

SECTION 5. To be eligible to Active Membership, a person must be at least 26 years of age, and be an officer or other employee of a Gas Company; or a Consulting Gas Engineer, or an employee of a Consulting Gas Engineer. He must be competent to act efficiently as the Manager of a department of a Gas Company's business and must have his chief interest in the gas business directly connected with the manufacture, sale, or utilization of gas, and not the manufacture or sale of apparatus or appliances used by Gas Companies.

SECTION 6. To be eligible as a Junior Member, a person must be over 20 years of age and be in the employ of a Gas Company, or of a Consulting Gas Engineer, and must be qualified either by experience or education to hold a responsible position under such employers.

SECTION 7. To be eligible as an Associate Member, a person must be engaged in a pursuit which constitutes a branch of gas engineering, or be otherwise qualified to assist in promoting the objects of the Institute.

SECTION 8. Charter Members shall be such of the present membership of the American, Ohio, or Western Gas Association as shall be certified by the officers of the same to the directors of the Institute as qualified respectively for Active, Junior or Associate membership, provided that to become a charter member, it shall be necessary for each person so certified to make application to the Directors of the Institute

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within a period of sixty days after notice has been sent him of the formation of the Institute.

ELECTION OF NEW MEMBERS.

SECTION 9. Honorary Members shall be proposed by the Directors and voted upon by ballot at a general meeting of the Institute. To be elected, a person proposed for Honorary Membership must receive the votes of nine-tenths of the members present and entitled to vote.

SECTION 10. Every application for either Active, Junior or Associate Membership shall be made to the Secretary in writing upon a form approved by the Directors, upon which shall be set forth as the grounds of the application a complete account of the qualifications and experience of the applicant and his agreement to conform, if elected, to the Constitution, By-Laws and Rules of the Institute, and shall be endorsed by at least two Active Members to whom the applicant is personally known. The Secretary shall submit each application to the Directors, who shall consider and act upon it and assign the applicant to the grade of membership to which, in their judgment, his qualifications entitle him. The name of each candidate thus approved by the Directors shall, unless objection is made by the applicant, be submitted to the voting membership for election by means of a letter ballot.

SECTION 11. It shall be competent for any Junior or Associate member to apply for transfer to another grade of membership. The application for such transfer shall be made in the same manner as in the case of a new applicant.

SECTION 12. Election to membership shall be by a sealed letter ballot, as the By-Laws shall provide. Adverse votes to the number of 2 per cent. of the votes cast shall be required to defeat the election of an applicant for any grade of membership. The Directors may, in their discretion, order a second ballot upon a defeated applicant, in which case adverse votes to the number of 4 per cent. of the votes cast shall be required to defeat the election.

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SECTION 13. Any person elected to the Institute, except Honorary Members, must subscribe to the Constitution and pay to the Treasurer the initiation fee and one year's dues for his grade of membership before he can be entitled to the rights and privileges, or can receive a certificate of membership. If this requirement is not complied with within six months of the notification of the election the applicant will be deemed to have declined the election and the election shall be void.

INITIATION FEES AND DUES.

SECTION 14. The initiation fee for membership in each grade shall be as follows:

For Active Members	$15.00
For Associate Members	15.00
For Junior Members	5.00

These initiation fees shall not include the dues for the current year in which the applicant is elected.

SECTION 15. A Junior Member, on promotion to any other grade of membership, shall pay an additional fee of $10.00, except that Charter Junior Members shall not be required to pay such additional fee. No person shall retain Junior membership for more than two years after becoming qualified for active membership.

SECTION 16. The annual dues, payable in advance, for membership in each grade shall be as follows:

For Active Members	$10.00
For Associate Members	10.00
For Junior Members	5.00

SECTION 17. The Directors may, in their discretion, permit any Active or Associate Member to become a Life Member in the same grade by the payment in one sum of an amount sufficient to purchase from a reputable life insurance company an annuity on the life of a person of the age of the applicant equal to the annual dues in his grade of membership. Such life member shall not be liable thereafter for annual dues. Life members of the associations dissolving shall only be re-

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quired to pay the difference, if any, between the sum computed as above and that already paid for their present life membership.

SECTION 18. The Directors shall have power by letter ballot to admit to Life Membership, without the payment of a life membership fee, any person who for a long term of years has been an active or an associate member, when, for special reasons, such an action would, in their judgment, promote the best interests of the Institute. Notice that such action is proposed shall have been given at a previous meeting of the Directors, and one dissenting vote shall defeat the proposed action.

SUSPENSIONS AND EXPULSIONS.

SECTION 19. A member whose dues for a year completely expired are not paid, shall not be entitled to vote, nor to participate in the deliberations of the Institute, nor to receive a copy of the proceedings. Any member whose dues shall remain unpaid for a term of three years may be dropped from the roll of membership by a vote of the Directors. A member dropped for non-payment of dues may, upon paying the amount he owes the Institute, be reinstated at the option of the Directors.

SECTION 20. The Directors may refuse to receive the dues of any member of any grade who shall have been adjudged by them to have violated the Constitution or By-Laws of the Institute, or who, in their opinion, shall have been guilty of conduct rendering him unfit to continue in its membership, and such person may be expelled from the Institute upon a recommendation to that effect made by the Directors at any general meeting of the Institute. The vote upon expulsion shall be by ballot and shall require two-thirds of the votes cast for its adoption.

SECTION 21. The Directors may transfer any member from his then present to any lower grade of membership. They may also refuse to receive the dues of any member who is no longer eligible to any grade. No transfer of grade shall be made, or refusal to accept dues recorded, except upon notice

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from the Secretary, whose duty it shall be to give such notice, that said member is no longer eligible for membership in his then present grade, and that said member has for a period of ninety days after notification of such non-eligibility, failed to apply for transfer. The vote in each case shall be by ballot, and shall require two-thirds of the votes cast for its adoption.

MANAGEMENT.

SECTION 22. The affairs of the Institute shall be managed by the Directors, subject to the control of the general meeting.

SECTION 23. The Board of Directors shall consist of the President, the two Vice-Presidents, the Secretary, the Treasurer, the Junior Past President, and until changed as hereinafter provided for, ten Active members of the Institute. Five members shall constitute a quorum for the transaction of business. If arrangements are made for co-operation between the Institute and district and state gas associations, as hereinafter provided for, the number of members of the Board elected from the Active Members of the Institute shall be increased from time to time, as it becomes necessary, in order to keep the number of Directors elected by the Institute equal to not less than two-thirds of the total number of both Institute and Associated Directors.

SECTION 24. Should a vacancy occur in the Board of Directors or in any elective office, except the Presidency or First Vice Presidency, through death, resignation or other cause, the Directors may elect an Active Member to fill the vacancy until the next annual election.

SECTION 25. The Directors shall regulate their own proceedings, and may, by resolution, delegate specific powers to an Executive Committee, or to any one or more of their members. No act of the Executive Committee, or of a delegate, shall be binding until it has been approved by a resolution of the Directors.

SECTION 26. The Board of Directors shall present at the annual meeting of the Institute a report verified by the President, Secretary and Treasurer, or by a majority of the mem-

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bers, which shall show the state of the finances of the Institute at the date of the report; the receipts and expenditures for the fiscal year immediately preceding; the names and places of residence of the persons who have been admitted to membership in the Institute during that year, and give an account of the action taken by the Directors upon matters coming before it and recommendations as to the action to be taken by the Institute. This report shall be filed with the records of the Institute and an abstract of it shall be entered in the minutes of the proceedings of the annual meeting.

OFFICERS.

SECTION 27. At each annual meeting there shall be elected from among the Active Members a President, two Vice Presidents, a Secretary, a Treasurer, and until otherwise provided for, five members of the Board of Directors. All of the officers shall be elected for one year, but the members of the Board of Directors shall be elected for two years. At the first general meeting ten members of the Board of Directors shall be elected, five to hold office for one year and five to hold office for two years.

SECTION 28. All elections shall be by ballot.

SECTION 29. The term of all elected officers shall begin on the adjournment of the annual meeting of the Institute at which they were elected. Officers shall continue in their respective offices until their successors have been elected and have accepted such election.

SECTION 30. The President and the retiring Active Members of the Board of Directors shall not be eligible for re-election the following year.

SECTION 31. Previous to each annual meeting it shall be the duty of the Directors to appoint a nominating committee of five members, none of whom shall be a Director. It will be the duty of this nominating committee to present at the annual meeting a list of the Active Members whom they recommend as officers for the ensuing year.

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SECTION 32. Twenty or more members entitled to vote may constitute themselves a special nominating committee with the same powers as the nominating committee appointed by the Directors.

SECTION 33. The Directors shall appoint from their own number immediately after the meeting at which they are elected a finance committee of three members.

SECTION 34. The President shall take the chair at all meetings of the Institute, of the Board of Directors and of committees at which he is present. He shall determine to which general committee any matter shall be referred.

SECTION 35. In the absence of the President one of the Vice Presidents shall take the chair, and in the absence of the President and Vice Presidents a Chairman shall be appointed by the Directors from among their own members.

SECTION 36. The duties of the Secretary shall be to take minutes of all proceedings of the Institute and of the Board of Directors, and to enter them in proper books for that purpose. He shall conduct the correspondence of the Institute, read minutes and notices of all the meetings, and also such papers and communications as are considered in the absence of their authors, and perform whatever other duties may be required in the Constitution and By-Laws appertaining to this department.

SECTION 37. The duties of the Treasurer shall be to receive and keep all annual dues and funds of the Institute, to keep correct accounts of same, and pay all bills approved by the President or a member of the Finance Committee, and he shall make an annual report to be submitted to the Institute.

SECTION 38. The duties of the Finance Committee shall be to audit the books, accounts and statements of the Treasurer; to invest the funds of the Institute, and to care generally for the finances of the Institute, subject to the control of the Directors.

SECTION 39. The duties of the Directors shall be to have the general management of the affairs of the Institute, and to

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prepare for its meetings. No paper or report that has not had the approval of the Directors shall be read at any meeting.

The Directors shall have the power to appoint, from time to time, a Committee on Arrangements from among the members to assist the Board of Directors in arranging for the meetings of the Institute. The Directors shall have power to fill for the unexpired term, any vacancies occurring by death, or resignation, in their own number, or in the general committees.

Any resolution, report or recommendation, that has not been considered and approved by the Directors, and that in the opinion of the Chair would have the effect of changing the policy of the Institute, or committing it to any new policy or opinion to which it had not theretofore been committed, should be referred, before adoption, to the Board of Directors, whose duty it shall be to report to the next regular meeting of the Institute upon such committal, if any, and its proper phrasing.

SECTION 40. There shall be two general committees, each reporting to the Board of Directors and responsible to the Board for such part of the work of the Institute as is delegated to it in accordance with the provisions of Sections 34, 41 and 42. Each committee shall be composed of six members, to be appointed each year by the President, and to serve one year.

SECTION 41. One general committee shall be called the Public Relations Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind affecting the relations between the Institute, or its members, and the public, or any governing bodies, except as herein provided.

SECTION 42. One general committee shall be called the Technical Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind having to do with the construction, operation and extension of gas works, and the conduct of the affairs of gas companies, not specifically delegated to the Public Relations Committee by Section 41, and except as herein otherwise provided.

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SECTION 43. Each general committee shall have the power to appoint sub-committees. Each sub-committee shall consist of one member of the general committee, the other members being taken from the general membership of the Institute, and shall exist at the pleasure of the general committee by which it was appointed, and to which its report shall be made.

MEETINGS AND PROCEEDINGS.

SECTION 44. The annual meeting of the Institute shall be held on the third Wednesday of October of each year, at such place as shall be designated by the Institute at the previous meeting. In case of emergency the Directors shall have the power to change the time or place of meeting, or both, as so designated, by a three-fourths vote of all its members, at the call of the President, and such vote may be taken by mail.

SECTION 45. The Secretary shall send notices to all members of the Institute at least fourteen days before each general meeting, mentioning the papers to be read and any special business to be brought before the meeting.

SECTION 46. Special meetings of the Institute may be called at the option of the Directors, and the Secretary shall call a special meeting on the written request of one hundred members.

The notices for special meetings shall be sent to all members at least three weeks before the date for which the meeting is called and shall state the business to be transacted, and no other shall be entertained.

SECTION 47. Thirteen members shall constitute a quorum.

SECTION 48. All questions shall be decided by any convenient system of open voting, the presiding officer to have a second or casting vote when necessary.

SECTION 49. Questions of a personal nature shall be decided by ballot, and all parliamentary procedure not specifically covered by this Constitution shall be governed in accordance with Roberts' Rules of Order.

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SECTION 50. Any member, with the concurrence of the presiding officer, may admit a friend to each meeting of the Institute, but such person shall not take part in any of the discussions, unless permission to do so be given by the meeting.

SECTION 51. All papers read at the meetings of the Institute must relate to matters, either directly or indirectly connected with the objects of the Institute, and must be approved by the Directors before being read.

SECTION 52. All papers, drawings or models submitted to the meetings of the Institute shall be and remain the property of the authors.

SECTION 53. The President, the Vice Presidents and the Chairmen of the two general committees shall constitute a Publication Committee, and nothing shall be included in the published reports of the Institute's Proceedings, or in any other publication issued by its authority, that has not been approved by at least two-thirds of the full membership of the Publication Committee.

SECTION 54. The Directors shall meet the day before each general meeting of the Institute, and on other occasions, when the President shall deem it necessary and the President shall be required to call a meeting at any time on the written request of five members of the Board. Of such special meetings reasonable notice shall be given by special call, in print or writing, specifying the business to be attended to.

AFFILIATION WITH LOCAL ASSOCIATIONS.

SECTION 55. The Board of Directors may in its discretion make, with any one (or each) of the district and state gas, or gas and electric, associations, now existing or hereafter to be formed, that will agree thereafter not to elect to voting membership any person connected in any way with the gas industry who is not directly identified with gas, or electric, interests within the district or state whose name it bears, to consult with the Institute before undertaking any original work of interest to the gas profession, and to do each year, under the

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direction of the Institute, a certain amount of original work, agreements for co-operation between the Institute and such associations. Each and every district or state gas, or gas and electric, association, with which such agreements are entered into shall be entitled to elect one of its members a member of the Board of Directors of the Institute, the member so elected to be in addition to those named in Section 23, provided that the number of such associated Directors shall never exceed one-third of the total membership of the Board. Should the Board of Directors provide for an executive committee, this committee shall include in its membership one man from each of the affiliated associations as long as the number of such associations does not exceed six. Thereafter there shall be on the executive committee at least six men who are members of affiliated associations and have among them membership in at least six such associations.

PROCEEDINGS.

SECTION 56. Each member of the Institute in good standing shall be entitled to and shall be furnished by the Secretary with a copy of the Proceedings of the Institute for the current year, in which shall be listed the names and addresses of the members. In any such list each member should be listed by the title, or titles, only, from which he derives his eligibility to his class of membership.

AMENDMENTS.

SECTION 57. All propositions for adding to or altering any of the provisions of the foregoing Constitution shall be laid before the Directors, who, if they see fit, may bring it before the next general meeting of the Institute and who shall be bound to do so on the requisition in writing of any ten members of the Institute. All such propositions shall be decided by ballot and shall require two-thirds of the vote cast for their adoption.

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BY-LAWS

(As amended March 17, 1908.)

1. (*SECTION 10.) Each member proposing a candidate for admission is required to make a confidential communication to the Secretary for forwarding to the Membership Committee, setting forth in detail such information, personally known to referee, as shall enable the directors to decide upon the eligibility of the candidate for admission to the Institute, except that in the event of the requisite number of members in good standing having personally signed the application of a candidate, this may be deemed sufficient endorsement and the requirement of the confidential communication referred to above shall not be obligatory, but shall be optional at the discretion of the Membership Committee. The Secretary shall be the judge of the competency and the signature of referees.

2. (SECTION 10.) In the absence of replies from the referees to inquiries for information, or if replies are not sufficiently explicit, the Secretary shall cause the applicant to be notified, and the application shall be held in abeyance.

3. (SECTION 10.) At their first meeting each year, the Directors shall appoint from among their own number a Membership Committee of five members. They shall pass on all applications for membership and report to the Directors. Any correspondence in regard to an applicant shall be destroyed when his name has been placed on the voting ballot, or upon withdrawal of the application.

4. (SECTION 12.) The Secretary shall, twice a year, on or about the first day of March and September, mail to each member entitled to vote, a ballot stating the names and respective grades of the candidates for membership in the Institute which have been approved by the Directors, and the time of the close of voting. The voter shall prepare his ballot by crossing out the names of candidates rejected by him, and shall enclose said ballot in a sealed blank ballot envelope, which

* Section references refer to corresponding sections of Constitution.

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he shall then enclose in a second sealed outer envelope on which he shall, for identification, write his name in ink. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Secretary. He shall be the judge of the competency and the signature of all voters. On the close of voting, the Secretary shall first open and destroy the outer envelopes, and shall then canvass the ballots, and certify the result to the Membership Committee.

The Secretary shall not receive any ballot after the stated time of the close of voting. A ballot without the endorsement of the voter, written in ink on the outer envelope, shall be considered as defective, and rejected by the Secretary.

The names of those persons elected to membership, with their respective grades, shall be embodied in a written report, signed by the Secretary, and presented to the next meeting of the Institute. The President shall then declare them duly elected to membership in the Institute. The Secretary may, in advance of any meeting, advise each candidate of the result of the canvass of the votes in his case. The names of applicants who are not elected shall neither be announced nor recorded in the "Proceeding."

The endorser of an applicant who has not been elected, may, with his consent, present to the Directors a written request for a re-submission of his name to ballot. The Directors may, in their discretion, by a three-fourths vote of the members present, order the name of the applicant placed on the next ballot for members.

5. (SECTION 13.) Section 13 of the Constitution shall be printed upon the notification of election to all members except Honorary Members.

6. (SECTION 14.) The initiation fee and annual dues of the first year shall be due and payable on notice of election to membership. Bills for the fee and dues should accompany the notification of election. Thereafter the annual dues shall be due and payable on the first day of October of each year.

7. (SECTION 14.) Upon payment of the initiation fee and annual dues, a newly elected member shall receive a copy of the volume of the proceedings containing the report of the

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meeting held in the then current fiscal year, and copies of any other publications of the Institute, which may have been distributed without charge to the members during that year, even though the date of issue of these publications is prior to that of the election of such member.

8. (SECTION 16.) Each member shall be entitled to a badge upon payment of an amount to be fixed from time to time by the Directors. Upon his ceasing to be a member, he shall return his badge, and receive therefor the sum of $2.00.

9. (SECTION 16.) Each member shall be entitled to a certificate of membership signed by the President and Secretary. Every such certificate *shall remain the property of the Institute* and shall be returned to the Secretary on demand of the Directors.

10. (SECTION 19.) The Treasurer shall present to the Directors the name of any member in arrears for more than one year.

11. (SECTION 26.) The Secretary shall furnish the Directors with the information needed for their annual report, excepting only as to finances, or to matters which have been entrusted to special committees. The financial report shall be made by the Treasurer to the Finance Committee.

12. (SECTION 26.) The fiscal year of the Institute shall begin September 1st.

13. (SECTION 28.) The President shall, at the first session of the Annual Meeting, appoint three Tellers of Election, who shall canvass the vote cast for officers, and report the result to the meeting.

14. (SECTION 31.) The Nominating Committee shall report at the first session, and a ballot be taken on their report at once, unless twenty or more members object. In such case, the ballot for officers shall take place at the first session of the second day.

15. (SECTION 31.) If the report of the Nominating Committee is not unanimously adopted, the Tellers of Election shall distribute ballots among the members.

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16. (SECTION 33.) When the appointment of a chairman is not included in the appointment of a committee, the latter shall elect their own chairman.

17. (SECTION 36.) The Secretary shall be in charge of the membership lists. He shall also be in charge of all other property of the Institute not distinctly pertaining to the Treasurer's work.

18. (SECTION 37.) The annual report of the Treasurer shall be embodied in the financial report of the Directors.

19. (SECTION 37.) Neither the Treasurer nor any other officer of the Institute shall pay out money except upon bills approved by the President and a member of the Finance Committee.

20. (SECTION 37.) The Treasurer shall furnish a bond for the faithful performance of his duties to such amount as the Finance Committee may require, such bond to be procured from an incorporated guarantee company at the expense of the Institute.

21. (SECTION 39.) The President, subject to subsequent approval by the Directors, may, in his discretion, appoint a member or members of the Institute to represent it at meetings of Associations of kindred aim or at public functions. Such delegates should be designated as "Honorary Vice Presidents," and their duties shall terminate with the occasion for which they are appointed.

22. (SECTION 39.) At their first meeting each year, the Directors shall appoint an Arrangement Committee to have charge of all the details connected with the next annual meeting, except only as to papers.

23. (SECTION 55.) Upon receipt of official notice from any district or state gas, or gas and electric association, of a desire to affiliate with the Institute and comply with the provisions of Section 55 of the Constitution, the Directors shall authorize the President and Secretary to execute an agreement with such district association. Upon execution of

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such agreement, the person designated by the district association as its representative on the Board of Directors, will be recognized as a member of such board to continue in office until his successor is appointed by the district association; or until the agreement is cancelled.

24. (SECTION 57.) Amendments of, or additions to, the By-Laws may be adopted by the Directors by a unanimous vote at any meeting. When objection is made, two weeks' notice and copy of the proposed changes shall be sent to each Director. At any meeting subsequent to such notice, a two-thirds vote will be sufficient for adoption.

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OFFICERS

OF THE

AMERICAN GAS INSTITUTE

1907—1908

President

ALEXANDER C. HUMPHREYS.....New York, N. Y.

First Vice President

HENRY L. DOHERTY.....New York, N. Y.

Second Vice President

WILLIAM A. BAEHR.....St. Louis, Mo.

Secretary and Treasurer

JAMES W. DUNBAR.....New Albany, Ind.

DIRECTORS

WALTON CLARK.....	Philadelphia, Pa.....	Ex-Officio	
FREDERICK H. SHELTON..	Philadelphia, Pa..	Term Exp.	1908
H. D. WHITCOMB, JR.....	Newark, N. J.....	" "	1908
JAMES T. LYNN.....	Detroit, Mich.....	" "	1908
L. L. KELLOGG.....	Sioux City, Ia....	" "	1908
F. W. STONE.....	Ashtabula, Ohio..	" "	1908
WALTON FORSTALL.....	Philadelphia, Pa...	" "	1909
EDWARD G. COWDERY....	Chicago, Ill.....	" "	1909
K. M. MITCHELL..	St. Joseph, Mo.....	" "	1909
J. H. JOURDAN	Brooklyn, N. Y...	" "	1909
J. A. NORCROSS.....	New Haven, Conn.	" "	1909

HEADQUARTERS OF

AMERICAN GAS INSTITUTE

United Engineering Societies' Building, 29 West 39th Street

NEW YORK CITY

WEST BISSELL, *Assistant Secretary*

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GENERAL COMMITTEES

1907–1908

Public Relations Committee

EDWARD G. COWDERY, Chairman.....Chicago, Ill.
I. C. COPLEY.....Aurora, Ill.
CHARLES F. PRICHARD.....Lynn, Mass.
JOHN GRIBBEL.....Philadelphia, Pa.
DONALD MCDONALD.....Louisville, Ky.
WALTON CLARK.....Philadelphia, Pa.

Technical Committee

WILLIAM H. GARTLEY, Chairman.....Philadelphia, Pa.
ALTEN S. MILLER.....Baltimore, Md.
WILLIAM A. BAEHR.....St. Louis, Mo.
WILLIAM E. MCKAY.....Boston, Mass.
R. B. BROWN.....Milwaukee, Wis.
ARTHUR G. GLASGOW.....London, Eng.

PUBLICATION COMMITTEE

THE PRESIDENT.
THE VICE PRESIDENTS.
THE CHAIRMAN OF THE PUBLIC RELATIONS COMMITTEE.
THE CHAIRMAN OF THE TECHNICAL COMMITTEE.

PAST PRESIDENTS

B. W. PERKINS.....1906
WALTON CLARK.....1907

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MEMBERS

OF THE

AMERICAN GAS INSTITUTE.

(The date with each name is that of election to membership.)

ACTIVE MEMBERS.

ABELL, H. C., October 17th, 1906.
Engineer American Light & Traction Company, 40 Wall Street, New York City.

ADAMS, B. C., October 17th, 1906.
General Superintendent, Lincoln Gas & Electric Company, 1323 O Street, Lincoln, Nebraska.

ADAMS, H. C., October 17th, 1906.
Vice President, Westmoreland Coal Company, 224 South 3rd Street, Philadelphia, Pennsylvania.

ADAMS, HENRY EASTLAND, October 17th, 1906.
Manager, Stockton Gas & Electric Company, 745 N. El Dorada Street, Stockton, California.

ADDICKS, FREDERICK P., October 17th, 1906.
Owner of Gas Properties, 42 Broadway, New York, New York.

ADDICKS, WALTER R., October 17th, 1906.
Consulting Engineer, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

AFRICA, WALTER G., October 17th, 1906.
Treasurer and Superintendent, Peoples Gas Light Company, 39 Hanover Street, Manchester, New Hampshire.

ALDRICH, F. B., October 17th, 1906.
General Manager, Pottsville Gas Company, 200 West Market Street, Pottsville, Pennsylvania.

ALDRICH, W. A., October 17th, 1906.
General Manager, Tacoma Gas Light Company, Tacoma, Washington.

ALLEN, WILLIAM H., October 17th, 1906.
Commercial Agent, Public Service Corporation of New Jersey, 763 Broad Street, Newark, New Jersey.

ALLISON, WALTER A., October 17th, 1906.
Assistant to Superintendent of Works, The U. G. I. Company, Philadelphia, Pennsylvania.

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ALLYN, GEORGE E., October 17th, 1906.
Superintendent of Distribution, Providence Gas Company, 20 Market Square, Providence, Rhode Island.

AMES, JOSEPH B., September 25th, 1907.
Superintendent of Mains and Services, Public Service Corporation, Jersey City, New Jersey.

AMES, KNOWLTON L., October 17th, 1906.
President, Benton Harbor & Saint Joe (Mich.) Gas Companies, 184 La Salle Street, Chicago, Illinois.

ANDERSON, WILLIAM C., October 17th, 1906.
General Manager, Wyoming Valley Gas & Electric Company, Plymouth, Pennsylvania.

ANDREWS, C. W., October 17th, 1906.
Assistant to the President, Zenith Furnace Company, Duluth, Minnesota.

ANDREWS, J. CHARLES, October 17th, 1906.
Turner Construction Company, 11 Broadway, New York City.

ARKWRIGHT, P. S., October 17th, 1906.
Vice President, Atlanta Gas Light Company, Electric & Gas Building, Atlanta, Georgia.

ARMINGTON, WILLIAM A., October 17th, 1906.
Superintendent, Nassau & Suffolk Lighting Company, Freeport, New York.

ARMSTRONG, F. S., October 17, 1906.
Superintendent and Manager, Macomb Electric Light & Gas Company, Macomb, Illinois.

ARTHUR, F. M., October 17th, 1906.
District Superintendent, United Gas Improvement Company, 1615 N. 9th Street, Philadelphia, Pennsylvania.

ATKINSON, G. G., October 17th, 1906.
Superintendent, Goshen Gas Company, Goshen, Indiana.

ATWOOD, C. CASSELS, October 17th, 1906.
Assistant Superintendent, New Amsterdam Gas Company, Vernon Avenue & Webster Avenue, Long Island City, New York.

AVERILL, A. S., October 17th, 1906.
President Cedar Rapids Gas Light Company, Cedar Rapids, Iowa.

AVERILL, GLENN M., October 17th, 1906.
Secretary, Cedar Rapids Gas Light Company, Cedar Rapids, Iowa.

BACHE, R. P., June 19th, 1907.
Manager Colorado Springs Light and Power Co., Colorado Springs, Colo.

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BACQUE, LOUIS H., October 17th, 1906.
Manager, Three-Rivers Gas, Heat & Power Company. Three-Rivers, Quebec, Canada.

BAEHR, WILLIAM ALFRED, October 17th, 1906.
Engineer, The Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

BAER, HERBERT S., October 17th, 1906.
Hancock, Michigan.

BAILEY, WILLIAM, October 17th, 1906.
Superintendent of Gas Department, Anniston Electric & Gas Company, 10th and Noble Streets, Anniston, Alabama.

BAILEY, W. FRANK, October 17th, 1906.
Superintendent of Distribution, Wilmington Gas & Electric Company, Box 264, Wilmington, Delaware.

BAINS, GEORGE B. 3d, October 17th, 1906.
Superintendent Gas Department, Merion and Radnor Gas & Electric Company, Ardmore, Pennsylvania.

BALDWIN, WAREHAM S., October 17th, 1906.
Superintendent, Sedalia Gas & Fuel Company, Sedalia, Missouri.

BALL, JAMES, October 17th, 1906.
Assistant Treasurer, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

BARKER, WILLIAM S., September 25th, 1907.
Assistant to Comptroller, Public Service Corporation, 763 Broad Street, Newark, New Jersey.

BARNES, ALBERT MALLARD, October 1st, 1907.
Treasurer and General Manager, Cambridge (Mass.) Gas Light Company, Cambridge, Massachusetts.

BARRET, A. H., October 17th, 1906.
Engineer, Louisville Gas Company, 729 Fourth Avenue, Louisville, Kentucky.

BARRETT, WILLIAM E., October 17th, 1906.
Gas Engineer, J. G. White & Company, 43 Exchange Place, New York, New York.

BARROWS, GEORGE S., October 17th, 1906.
Manager, Gas Appliance Department, Wyandotte Gas Company, Kansas City, Kansas.

BARTHOLD, W. H., October 17th, 1906.
Engineer for various Gas Companies, Saginaw, Michigan.

BATTIN, HENRY S., October 17th, 1906.
Assistant to Superintendent of Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

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BATTIN, ISAAC, October 17th, 1906.
Treasurer and Engineer, Omaha Gas Company, 1224 Farnam Street, Omaha, Nebraska.

BAUERHYTE, WILLIAM, October 17th, 1906.
Vice-President, Pasadena Consolidated Gas Company, 25 East Colorado Street, Pasadena, California.

BAXTER, ISAAC C., October 17th, 1906.
President, Bucyrus (Ohio) Gas & Electric Light Company, Wayne County Bank Building, Detroit, Michigan.

BAYLEY, C. CLAY, October 17th, 1906.
Assistant to Engineer, Washington Gas Light Company, Twenty-sixth and G Streets, Washington, District of Columbia.

BEACH, E. CHANDLER, October 17th, 1906.
General Manager, Pulaski Gas Light Company, Little Rock, Arkansas.

BEADENKOPF, GEORGE, October 17th, 1906.
Engineer, Consolidated Gas & Electric Light & Power Company, Lexington and Liberty Streets, Baltimore, Maryland.

BEADLE, ALBERT B., October 17th, 1906.
Consulting Gas Engineer, 82 Beaver Street, New York, New York.

BEAL, A. R., October 17th, 1906.
Manager Gas Department, Newburgh Light, Heat & Power Company, Newburgh, New York.

BEAL, T. R., Octber 17th, 1906.
General Manager, Poughkeepsie Light, Heat & Power Company, 309 Main Street, Poughkeepsie, New York.

BEAL, WILLIAM R., October 17th, 1906.
President and General Manager, Newburgh Light, Heat & Power Company, Newburgh, New York.

BEARDSLEE, CHARLES S., October 17th, 1906.
Superintendent, Cleveland Gas Light & Coke Company, Front Avenue, N. W., Cleveland, Ohio.

BEAUMONT, WALTER W., September 25th, 1907.
Assistant Superintendent Street Lighting Department. The Equitable Illuminating Company, 24 North 22nd Street, Philadelphia, Pennsylvania.

BECK, GEORGE W., October 17th, 1906.
Superintendent Sunbury Gas Company, Sunbury, Pennsylvania.

BEDLE, WILLIAM E., October 17th, 1906.
Manager, Citizens Light & Fuel Company, South Amboy, New Jersey.

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BEGGS, JOHN I., October 17th, 1906.
President, Laclede Gas Light Company, St. Louis, Mo., Milwaukee, Wisconsin.

BEIRNE, EDWARD J. O., January 3rd, 1907.
Consulting Engineer, Hattiesburg (Miss.) Gas Company, Empire Building, Atlanta, Georgia.

BELL, ERNEST WILLIAM, October 17th, 1906.
Consulting Engineer, 1332 West Jefferson Street, Los Angeles, California.

BEMENT, A., October 17th, 1906.
Consulting Engineer, American Trust Building, Chicago, Illinois.

BENNETT, CHARLES W., October 17th, 1906.
Superintendent, Consolidated Gas Company of New Jersey, 635 Mattison Avenue, Asbury Park, New Jersey.

BENSON, FRED S., October 17th, 1906.
Chief Engineer, Eastern Division, Brooklyn Union Gas Co., Kent Avenue and Cross Street, Brooklyn, New York.

BERGER, E. T., October 17th, 1906.
Secretary, Union Gas & Electric Company, Bloomington, Ill. 818 Penobscot Building, Detroit, Michigan.

BERKLEY, Jos. M., October 17th, 1906.
Engineer, City Gas Company of Los Angeles, California.

BERTKE, WILLIAM JOHN, October 1st, 1907.
Assistant Superintendent Wyandotte Gas Company, Kansas City, Kansas.

BERTRAND, P. A., October 17th, 1906.
General Manager, Jefferson City Light, Heat & Power Company, Jefferson City, Missouri.

BIGELOW, ARTHUR F., October 17th, 1906.
Superintendent, Allentown Gas Company, 516 Hamilton Street, Allentown, Pennsylvania.

BILL, BENJAMIN P., October 17th, 1906.
Assistant Superintendent, Springfield Gas Light Company, Springfield, Massachusetts.

BISSELL, WEST, October 17th, 1906.
Consulting Engineer, Jersey City, New Jersey.

BIXBY, HOWARD, October 17th, 1906.
Superintendent, Green Bay Gas & Electric Company, 204 North Washington Street, Green Bay, Wisconsin.

BIXBY, W. A., October 17th, 1906.
General Manager, Springfield Gas & Electric Company, Springfield, Missouri.

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BLAUVELT, WARREN S., October 17th, 1906.
Superintendent, Coke Oven Department, Detroit Works, The Solvay Process Company, Detroit, Michigan.

BLOWERS, FRANK W., October 17th, 1906.
Secretary and General Manager, Kalamazoo Gas Company, Kalamazoo, Michigan.

BOARDMAN, A. E., October 17th, 1906.
Macon Gas Light & Water Company, 41 Wall Street, New York, New York.

BODINE, SAMUEL TAYLOR, October 17th, 1906.
First Vice-President and General Manager, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

BOND, CHARLES O., January 3rd, 1907.
Chief Photometrist, Philadelphia Gas Works, 24 North Twenty-second Street, Philadelphia, Pennsylvania.

BOONE, CHARLES, October 17th, 1906.
Superintendent, New Amsterdam Gas Company, 432 Hopkins Avenue, Astoria, Long Island, New York.

BORGNER, CYRUS, October 17th, 1906.
President, Cyrus Borgner Company, 234 North Twenty-third Street, Philadelphia, Pennsylvania.

BOWEN, F. W., October 17th, 1906.
Superintendent of Distribution, Consolidated Gas Company of New Jersey, 164 Broadway, Long Branch, New Jersey.

BRADLEY, CHARLES W., October 17th, 1906.
Engineer, North Western Gas Light & Coke Company, 115 North Oak Park Avenue, Oak Park, Illinois.

BRADLEY, FRED L., October 17th, 1906.
Superintendent 99th Street Station, Consolidated Gas Company of New York, 302 East Ninety-ninth Street, New York, New York.

BRADLEY, S., October 17th, 1906.
President, Atlantic City Gas & Water Company, Atlantic City, New Jersey.

BRADLEY, WILLIAM H., October 17th, 1906.
Chief Engineer, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

BRADY, JAMES C., January 3rd, 1907.
Director, New Amsterdam Gas Company, 54 Wall Street, New York, New York.

BRADY, JOHN T., October 17th, 1906.
Assistant Treasurer, Denver Gas & Electric Company, 405 Seventeenth Street, Denver, Colorado.

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BRAINE, JOHN H., October 17th, 1906.
Superintendent of Distribution, Public Service Corporation of New Jersey, 35 Front Street, Newark, New Jersey.

BREDEL, FRED, October 17th, 1906.
Gas Engineer, 405 Keene Street, Milwaukee, Wisconsin.

BRIGGS, G. W., October 17th, 1906.
Superintendent, Gas Department Michigan City Gas and Electric Company, Michigan City, Indiana.

BRITSCH, MATHIAS, October 17th, 1906.
Superintendent, Cicero Station, North Western Gas Light and Coke Company, Lombard Avenue and G. W. Tracks, Oak Park, Illinois.

BRITTON, JOHN A., October 17th, 1906.
President California Gas and Electric Corporation, 925 Franklin Street, San Francisco, California.

BRONAX, WM. F., October 1st, 1907.
Assistant Superintendent, Allentown Gas Company, Allentown, Pennsylvania.

BROWN, ERNEST C., October 17th, 1906.
Secretary and Treasurer, Boone (Iowa) Gas Company, Editor, Progressive Age, 280 Broadway, New York, New York.

BROWN, R. B., October 17th, 1906.
Engineer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

BROWN, ROBERT F., October 17th, 1906.
General Manager, Mankato Gas & Electric Light Company, Mankato, Minnesota.

BROWN, W. O., October 17th, 1906.
Foreman, Public Service Corporation of New Jersey, 256 North Park Street, East Orange, New Jersey.

BRUCE, HOWARD, October 17th, 1906.
With Bartlett, Hayward & Company, Baltimore, Maryland.

BRUNDRETT, ERNEST L., October 17th, 1906.
General Auditor, United Gas Improvement Company, 100 North Broad Street, Philadelphia, Pennsylvania.

BRYANT, CHARLES F., October 17th, 1906.
Auditor, Mohawk Valley Company, 527 Fifth Avenue, New York, New York.

BUCHER, PAUL, October 17th, 1906.
Superintendent, White Plains District Westchester Lighting Company, 29 Court Street, White Plains, New York.

BUCK, H. M., October 17th, 1906.
Manager, Waukesha Gas & Electric Company, Waukesha, Wisconsin.

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BULLOCK, B. F., October 17th, 1906.
Superintendent, City Gas Works, Municipal Plant, Fredericksburg, Virginia.

BUMP, MILAN R., October 17th, 1906.
Engineer, The Denver Gas & Electric Company, 60 Wall Street, New York, New York.

BUNKER, THEODORE, October 17th, 1906.
Engineer, Gas Department, Passaic Division, Public Service Corporation, 188 Ellison Street, Paterson, New Jersey.

BURGESS, C. F., October 17th, 1906.
Professor of Chemical Engineering, University of Wisconsin, Madison, Wisconsin.

BURGI, HERMAN, October 17th, 1906.
Superintendent, Central Union Gas Company, 1173 East 139th Street, New York, New York.

BURLEIGH, JOHN J., September 25th, 1907.
Vice-President, Public Service Corporation, 418 Federal Street, Camden, New Jersey.

BURRITT, DWIGHT F., October 1st, 1907.
Superintendent, Springfield Gas Light Company, Springfield, Massachusetts.

BURT, AUSTIN, October 17th, 1906.
General Superintendent, Citizens Gas & Electric Company, Waterloo, Iowa.

BUSCH, JOHN L., October 17th, 1906.
Superintendent Gas Department, Decatur Railway & Light Company, Decatur, Illinois.

BUSH, ROBERT WILDER, October 17th, 1906.
Engineer, Metropolitan Works, Brooklyn Union Gas Company, 12th Street, Brooklyn, New York

BUTLER, MATTHEW W., October 17th, 1906.
Chief Engineer, Leeds Process Company, 5027 Larchwood Avenue, Philadelphia, Pennsylvania.

BUTTERWORTH, C. W., October 17th, 1906.
Superintendent, Milton Gas Company, Milton, Pennsylvania.

BUTTERWORTH, IRVIN, October 17th, 1906.
Vice-President and General Manager, Detroit City Gas Company, 230 Woodward Avenue, Detroit, Michigan.

BYERS, C. A., October 17th, 1906.
Consulting Engineer, 3201 Collingwood Avenue, Toledo, Ohio.

BYRNE, EDWARD J., October 17th, 1906.
Engineer, Citizens Works, Brooklyn Union Gas Company, Fifth and Hoyt Streets, Brooklyn, New York.

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BYRNE, THOMAS E., October 17th, 1906.
Engineer, Kings County Lighting Company, 5912 New Utrecht Avenue, Brooklyn, New York.

CABOT, JOHN, October 17th, 1906.
Manufacturer of Purifier Trays, 1412 Adams Street, Hoboken, New Jersey.

CAGNEY, J. J., October 17th, 1906.
Assistant Secretary and Treasurer, Montreal Light, Heat & Power Company, Box 2396, Montreal, Canada.

CAHILL, WILLIAM J., October 17th, 1906.
General Manager, Gas Department, Utica Gas & Electric Company, 217 Genesee Street, Utica, New York.

CALLENDER, ELBERT P., October 17th, 1906.
Editor, American Gas Light Journal, 42 Pine Street, New York, New York.

CAMPBELL, ALEX J., October 17th, 1906.
General Manager, New London Gas & Electric Company, New London, Connecticut.

CAMPBELL, S. K., October 17th, 1906.
Superintendent, Nassau and Suffolk Lighting Company, Hempstead, New York.

CANTRIL, ARTHUR N., October 17th, 1906.
General Manager and Treasurer, Pueblo Gas and Fuel Company, 509 North Main Street, Pueblo, Colorado.

CARPENTER, HAROLD EUGENE, September 25th, 1907.
Superintendent of Construction, The Astoria Light, Heat & Power Company, 142 East 27th Street, New York, New York.

CARSON, GEORGE S., October 17th, 1906.
President, Iowa City Gas Light Company, Iowa City, Iowa.

CARTER, ROBERT A., October 1st, 1907.
Vice-President, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

CASTOR, WILLIAM A., October 17th, 1906.
Superintendent of Meters, United Gas Improvement Company, 1646 Dyre Street, Philadelphia, Pennsylvania.

CATHELS, EDMUND, October 17th, 1906.
Engineer, Providence Gas Company, Providence, Rhode Island.

CATHELS, WILLIAM M., October 17th, 1906.
206 Milton Street, Montreal, Canada.

CAUSEBROOK, W. R., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 129 East Front Street, Plainfield, New Jersey.

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CHADWELL, WILLIAM H., September 25th, 1907.
Superintendent, Market Street Gas Works, Public Service Corporation, Newark, New Jersey.

CHAMBERLIN, GLENN R., October 17th, 1906.
Secretary and Manager, Commercial Department, Grand Rapids Gas Light Company, Ottawa and Pearl Streets, Grand Rapids, Michigan.

CHANNON, HARRY O., September 25th, 1907.
Manager, Quincy Gas, Electric and Heat Company, 422 Maine Street, Quincy, Illinois.

CHEWNING, WALTER L., September 25th, 1907.
Superintendent, Front Street Gas Works, Public Service Corporation, Newark, New Jersey.

CHICHESTER, ALFRED A., October 17th, 1906.
Division Superintendent, Peoples Gas Light & Coke Company, 485 East Forty-second Street, Chicago, Illinois.

CHILD, RALPH S., October 17th, 1906.
Treasurer, Child, Hulswit & Company, Operating Gas & Electric Properties, 411 Michigan Trust Building, Grand Rapids, Michigan.

CHOATE, ROBERT R., October 17th, 1906.
Manager Commercial Department, Muskegon Traction & Lighting Company, Muskegon, Michigan.

CHOLLAR, BYRON E., October 17th, 1906.
Gas Engineer, 2840 Troost Avenue, Kansas City, Missouri.

CHUBB, CHESTER N., October 17th, 1906.
Superintendent, Sioux Falls Gas Light Company, 9th Street and Main Avenue, Sioux Falls, South Dakota.

CHUBBUCK, H. E., October 17th, 1906.
General Manager, Citizens Lighting Company, La Salle, Illinois.

CLABAUGH, G. W., October 17th, 1906.
Vice-President and Secretary, Omaha Gas Company, Omaha, Nebraska.

CLAPP, G. N., October 17th, 1906.
Secretary, Treasurer and General Manager, Middletown Gas & Electric Company, Middletown, Ohio.

CLARK, JOHN A., JR., October 17th, 1906.
Superintendent of Distribution, Public Service Corporation of New Jersey, 268 N. Park Street, East Orange, New Jersey.

CLARK, JOHN C. D., October 17th, 1906.
Commercial Agent, Peoples Gas Light and Coke Company, Michigan Avenue and Adams Street, Chicago, Illinois.

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CLARK, R. W., October 17th, 1906.
Care Minneapolis General Electric Company, Minneapolis, Minnesota.

CLARK, WALTON, October 17th, 1906.
Third Vice-President, The United Gas Improvement Company, N. W. Corner Broad and Arch Streets, Philadelphia, Pennsylvania.

CLARK, WILLIAM J., October 17th, 1906.
Vice-President, Westchester Lighting Company, Mount Vernon, New York.

CLARKE, JOSEPH, October 1st, 1907.
Manager, Cape Girardeau (Missouri) Water, Gas and Electric Company, Washington Hotel, St. Louis, Missouri.

CLARY, EDWARD D., October 17th, 1906.
Secretary and Superintendent, Burlington Gas Light Company, 215 Jefferson Street, Burlington, Iowa.

CLAUSEN, WILLIAM F., October 17th, 1906.
Superintendent and Manager, Union Gas & Electric Company, 316 North Main Street, Bloomington, Illinois.

CLEMENTS, W. B., October 17th, 1906.
Treasurer, Peekskill Lighting and Railroad Company, Ossining, New York.

CLINE, W. B., October 17th, 1906.
President and General Manager, Los Angeles Gas & Electric Company, 645 South Hill Street, Los Angeles, California.

COATE, P. S., October 17th, 1906.
Manager and Secretary-Treasurer, Chatham Gas Company, Limited, King Street West, Chatham, Ontario, Canada.

COBB, B. C., October 17th, 1906.
Vice-President, Bay City (Michigan) Gas Company, 7 Wall Street, New York, New York.

COBB, S. P., October 17th, 1906.
Engineer Canandagua Gas Light Company, Canandagua, New York.

COFFIN, JOHN A., October 17th, 1906.
Superintendent and Agent, Gloucester Gas Light Company, 96 Main Street, Gloucester, Massachusetts.

COGGSHALL, HENRY E., October 17th, 1906.
Treasurer and General Manager, Fitchburg Gas & Electric Light Company, 374 Main Street, Fitchburg, Massachusetts.

COHN, CHAS. M., June 19th, 1907.
Secretary, Consolidated Gas, Electric Light and Power Co., of Baltimore, Baltimore, Maryland.

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COLE, C. M., October 17th, 1906.
Assistant Superintendent, Wyandotte Gas Company, Kansas City, Kansas.

COLE, GEORGE M., October 17th, 1906.
Manager, Plattsburgh Light, Heat & Power Company, 28 Margaret Street, Plattsburgh, New York.

COLE, WM. W., October 17th, 1906.
President and General Manager, Elmira Water, Light and Railway Company, Elmira, New York.

COLLINS, CARROLL, October 17th, 1906.
Treasurer and General Manager, Marshall Gas Light Company, Marshall, Michigan.

COLLINS, CHARLES RUSSELL, October 17th, 1906.
Consulting Engineer, 321 Globe Building, Seattle, Washington.

COLLINS, DAVID J., October 17th, 1906.
Sales Agent, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

COLLINS, HENRY P., October 17th, 1906.
Manager, Herkimer County Light and Power Company, 587 Albany Street, Little Falls, New York.

COLVIN, J. E., October 17th, 1906.
Superintendent, Muncie Gas Light & Fuel Company, 301 East Main Street, Muncie, Indiana.

COMBS, ROGER B., October 17th, 1906.
Engineer with The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

CONGDON, RICHARD C., October 17th, 1906.
Manager, Atlanta Gas Light Company, Atlanta, Georgia.

CONLIN, JOHN J., October 17th, 1906.
General Foreman, Savannah Gas Company, P. O. Box 426, Savannah, Georgia.

CONNERS, MATHIAS, October 17th, 1906.
Superintendent, People's Gas Light and Coke Company, 31st Street and Pitney Court, Chicago, Illinois.

COOK, CHAS. G., September 25th, 1907.
Agent, Gas and Electric Departments Public Service Corporation, 222 East State Street, Trenton, N. J.

COOK, HENRY R., JR., September 25th, 1907.
Superintendent, Consumers' Gas Works, Public Service Corporation, Jersey City, N. J.

COOKE, ALFRED S., October 17th, 1906.
Auditor, Union Gas & Electric Company, 40 Wall Street, New York, New York.

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COOMBS, MOSES, October 17th, 1906.
Superintendent Gas Department, Youngstown Consolidated Gas & Electric Company, 1002 High Street, Youngstown, Ohio.

COOPER, W. H., October 17th, 1906.
Superintendent, Chuctanuda Gas Light Company, 33 Market Street, Amsterdam, New York.

COPLEY, I. C., October 17th, 1906.
President, Western United Gas & Electric Company, Aurora. Illinois.

CORNISH, R. C., October 17th, 1906.
Assistant Engineer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

CORSCOT, JOHN, October 17th, 1906.
General Manager, Madison Gas & Electric Company, Madison, Wisconsin.

CORTIS, DWIGHT T., October 17th, 1906.
Manager, Boston Gas Appliance Exchange, 16-20 West Street. Boston, Massachusetts.

COSGROVE, W. L., October 17th, 1906.
Atlanta, Georgia.

COVERT, IRA C., October 1st, 1907.
Superintendent, Gas Department, The Paducah Light & Power Company, Paducah, Kentucky.

COWDERY, EDWARD G., October 17th, 1906.
Peoples Gas Light & Coke Company, Michigan Avenue and Adams Street, Chicago, Illinois.

COWPERTHWAIT, B. W., October 17th, 1906.
Secretary, Treasurer and Manager, Faribault Gas & Electric Company, Faribault, Minnesota.

CRAFTS, HARRY C., October 17th, 1906.
Superintendent, Pittsfield Coal Gas Company, 30 South Street, Pittsfield, Massachusetts.

CRAHAN, B. J., October 17th, 1906.
Superintendent Portsmouth Gas Company, Portsmouth, Ohio.

CRAWFORD, Elmer, October 17th, 1906.
Superintendent, Sterling Gas Company, Sterling, Illinois.

CRAWFORD, H. T., October 17th, 1906.
Cashier, Waukegan Gas Company, Waukegan, Illinois.

CRAWFORD, RONALD, October 17th, 1906.
General Manager, Stamford Gas & Electric Company, Stamford, Connecticut.

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CRAWFORD, THOMAS, January 3rd, 1907.
General Manager, Clinton Gas Light & Coke Company, Clinton, Iowa.

CRESSLER, A. D., October 17th, 1906.
President and Engineer, Kerr Murray Mfg. Company, Fort Wayne, Indiana.

CRESSON, B. F., October 17th, 1906.
General Manager, Easton Gas & Electric Company, Easton, Pennsylvania.

CRIGHTON, D. K., October 17th 1906.
Engineer, C. H. Geist Company, Commercial National Bank Building, Chicago, Illinois.

CRILLEY, ROGER, October 17th, 1906.
General Foreman, Elizabethtown Gas Light Company, 19 Loomis Street, Elizabeth, New Jersey.

CRISFIELD, J. A. P., October 17th, 1906.
Engineer of Construction, United Gas Improvement Company, 1405 Arch Street, Philadelphia, Pennsylvania.

CRITCHLOW, E. C., October 17th, 1906.
Manager, Citizens Heat & Light Company, Elwood, Indiana.

CRONIN, ERNEST A., October 17th, 1906.
Assistant Secretary, Kansas City (Mo.) Gas Company, Kansas City, Missouri.

CROSS, PHILIP, October 17th, 1906.
Manager, Commercial Department, Denver Gas & Electric Company, Denver, Colorado.

CROW, A. D., October 17th, 1906.
Cashier, Oberlin Gas & Electric Company, 49 South Main Street, Oberlin, Ohio.

CROWELL, F. B., October 17th, 1906.
Consulting and Contracting Engineer, 5 Gould Building, Atlanta, Georgia.

CROWLEY, JOHN P., October 17th, 1906.
Secretary and Treasurer, St. Paul Gas Light Company, St. Paul, Minnesota.

CUNNINGHAM, JOHN H., October 17th, 1906.
Secretary and Treasurer, Westminster Gas Light Company, Westminster, Maryland.

CURRAN, G. W., October 17th, 1906.
Assistant General Agent, Philadelphia Gas Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

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CURTIS, SAMUEL P., October 17th, 1906.
General Manager, American Gas Company, 222 South Third Street, Philadelphia, Pennsylvania.

CURTISS, GEO. W., September 25th, 1907.
Superintendent, Camden Coke Works, Gas Department, Camden, New Jersey.

CUTCHEON, MAX. H., October 17th, 1906.
General Manager, Houghton County Gas and Coke Company, Hancock, Michigan.

DALES, JAMES STEWART, JR., October 17th, 1906.
Consulting Engineer, Child, Hulswit & Company, 411 Michigan Trust Building, Grand Rapids, Michigan.

DALY, AUGUSTIN J., October 17th, 1906.
Superintendent, North Division Street Department Laclede Gas Light Company, 1128 North Kingshighway, St. Louis, Missouri.

DALY, MARTIN B., October 17th, 1906.
President and General Manager, East Ohio Gas Company, 1447 East 6th Street, Cleveland, Ohio.

DASHIELL, P. T., October 17th, 1906.
Assistant Engineer, Gas Department, Essex Division, Public Service Corporation, 224 Broad Street, Newark, New Jersey.

DAUGHERTY, GEORGE, October 17th, 1906.
Superintendent, Warren Gas Light Company, 409 Adams Street, Warren, Ohio.

DAVIDSON, EDWARD S., October 17th, 1906.
Superintendent, Acetylene Apparatus Manufacturing Company, 25th and Butler Streets, Chicago, Illinois.

DAVIDSON, ROLLAND A., October 17th, 1906.
President and Manager, Hudson County Gas & Electric Company, 58 William Street., New York, New York.

DAVIES, H. W., October 17th, 1906.
Superintendent of Pintsch Compressing Company, 303 South 30th Street, Philadelphia, Pennsylvania.

DAVIS, DAVID, October 17th, 1906.
Secretary, Litchfield Gas Company, Litchfield, Illinois.

DAVIS, ERNEST H., October 17th, 1906.
Treasurer, Mifflin County Gas & Electric Company, Lewiston, Pennsylvania.

DAVIS, R. N., January 3rd, 1907.
Assistant Superintendent, Universal Gas Company, 3138 South Park Avenue, Chicago, Illinois.

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DAWES, FRED A., January 3rd, 1907.
President Gainesville (Texas) Gas Company, 703 Rookery Building, Chicago, Illinois.

DAWES, RUFUS C., October 17th, 1906.
President Mobile (Alabama) Gas Company, 621 New York Life Building, Chicago, Illinois.

DAWSON, GEORGE H., October 17th, 1906.
Superintendent Station C, Western United Gas & Electric Company, 343 North Ashland Avenue, La Grange, Illinois.

DAY, C. L., October 17th, 1906.
General Superintendent Street and Meter Department, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

DELL, JOHN, October 17th, 1906.
President, Hannibal Gas & Electric Company, 411 Olive Street, St. Louis, Missouri.

DENISON, HARRY, October 17th, 1906.
Fitter-Cranford Gas Light Company, Westfield, New Jersey.

DEXTER, MACDOUGALD, October 17th, 1906.
Superintendent, Gas Light Company of Columbus, Columbus, Georgia.

DEWEY, V. F., October 17th, 1906.
Superintendent of Manufacturing and Distribution, Detroit City Gas Company, 230 Woodward Avenue, Detroit, Michigan.

DIALL, M. N., October 17th, 1906.
Superintendent, Terre Haute Gas Company, Terre Haute, Indiana.

DIBBENS, W. Z., October 17th, 1906.
Manager, Guthrie Gas Company, Guthrie, Oklahoma.

DICKEL, CARL A., October 17th, 1906.
Secretary, Cyrus Borgner Company, 326 North Robinson Street, Philadelphia, Pennsylvania.

DICKERSON, JAMES, October 17th, 1906.
Manager, Peoples Gas & Electric Company, 70 East First Street, Oswego, New York.

DICKEY, CHARLES H., October 17th, 1906.
Director, Consolidated Gas Electric Light and Power Company of Baltimore, Box 773, Baltimore, Maryland.

DIFFENDERFER, J. G., January 3rd, 1907.
Manager, Dauphin County Gas Company, Steelton, Pennsylvania.

DIXON, J. ALFRED, October 17th, 1906.
General Superintendent, Pintsch Compressing Company, No. 2 Rector Street, New York, New York.

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DIXON, R. M., October 17th, 1906.
Vice President and Manager, Pintsch Compressing Company, No. 2 Rector Street, New York, New York.

DOBBIN, G. B., January 16th, 1907.
Auditor, Hodenpyl Walbridge and Company, No. 7 Wall Street, New York, New York.

DOCTEUR, L. A., October 17th, 1906.
Superintendent Gas Works, Montgomery Light & Water Power Company, Montgomery, Alabama.

DODD, WILLIAM S., October 17th, 1906.
Treasurer, Laclede Gas Light Company, 10 Locust Street, St. Louis, Missouri.

DODS, JOHN C., October 17th, 1906.
Engineer and Superintendent, Edgar Zinc Company, Cherryville, Kansas.

DOHERTY, HENRY L., October 17th, 1906.
Vice President, American Light and Traction Company, 60 Wall Street, New York, New York.

DOIG, GEORGE I., October 17th, 1906.
Superintendent and General Manager, Gainesville Gas & Electric Company, Gainesville, Florida.

DOLE, PARR H., October 17th, 1906.
Engineer, Improved Equipment Company, 60 Wall Street, New York, New York.

DOLE, WALTER S., October 17th, 1906.
Consulting Engineer, 255 King Street, Portland, Oregon.

DOLLEY, GEORGE M., October 17th, 1906.
Manager, Peru American Gas Company, Peru, Indiana.

DOLPH, A. M., October 17th, 1906.
President and Treasurer, Paris (Ky.) Gas Light Company, The Auburndale, Mt. Auburn, Cincinnati, Ohio.

DONAHUE, E. J., October 17th, 1906.
Engineer, Gas Department, Hudson and Bergen Divisions, Public Service Corporation of New Jersey, Sixth and Provost Streets, Jersey City, New Jersey.

DORNER, WILLIAM F., October 17th, 1906.
Superintendent, 25th Ward Gas Works, United Gas Improvement Company, Richmond & Tioga Streets, Philadelphia, Pennsylvania.

DORR, WILLIAM J., September 25th, 1907.
Superintendent of Gas Distribution, Los Angeles Gas & Electric Company, 645 South Hill Street, Los Angeles, California.

DOTY, PAUL, October 17th, 1906.
Vice-President and General Manager, St. Paul Gas Light Company, 159 East Sixth Street, St. Paul, Minnesota.

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DOUGLAS, HENRY W., October 17th, 1906.
Manager, Ann Arbor Gas Company, 211 East Huron Street, Ann Arbor, Michigan.

DOUGLAS, R. C., October 17th, 1906.
General Manager, Manitowoc Gas Company, Manitowoc, Wisconsin.

DOUGHERTY, BENJ. A., October 17th, 1906.
Superintendent, Richmond Water & Light Company, Richmond, Kentucky.

DOUTHIRT, W. F., October 17th, 1906.
Secretary, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

DOW, ALEX., October 17th, 1906.
Vice-President and General Manager, Edison Illuminating Company, 18 Washington Avenue, Detroit, Michigan.

DOWNEY, JAMES N., September 25th, 1907.
Assistant Superintendent Camden Coke Company, Camden, New Jersey.

DUNBAR, JAMES W., October 17th, 1906.
Superintendent, United Gas & Electric Company, 507 Bank Street, New Albany, Indiana.

DUNCAN, F. C., October 17th, 1906.
Manager, Princeton Gas Company, Princeton, Illinois.

DUNHAM, J. C., October 17th, 1906.
Superintendent of Construction, Stone & Webster Engineering Corporation, Pensacola, Florida.

DUNLAP, H., October 17th, 1906.
Treasurer and Manager, Emporia Electric & Gas Light Company, Emporia, Kansas.

DUNN, F. S., October 17th, 1906.
Superintendent, Municipal Gas Company, 1131 Broadway, Albany, New York.

DUSENBERRY, JAMES P., September 25th, 1907.
Treasurer, Public Service Corporation, 763 Broad Street, Newark, N. J.

DUSTIN, GUY K., October 17th, 1906.
Superintendent, Hartford City Gas Light Company, 8 Front Street, Hartford, Connecticut.

DUTTER, H. O., October 17th, 1906.
Superintendent and Manager, Bucyrus Gas & Electric Light Company, Bucyrus, Ohio.

DUTTON, LEWIS R., October 17th, 1906.
President and Manager, Jenkintown & Cheltenham Gas Company, Wyncote, Pennsylvania.

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DUTTON, R. H., October 17th, 1906.
President and Manager, Hanover Gas Company, Hanover, Pennsylvania.

EARNSHAW, EDWARD H., October 17th, 1906.
Assistant General Manager, Gas Department, Public Service Corporation, Newark, New Jersey.

EASTON, FREDERICK W., October 17th, 1906.
President Pawtucket Gas Company, 162 East Avenue, Pawtucket, Rhode Island.

EATON, ALFRED B., October 17th, 1906.
Vice President, Sheboygan Gas Light Company, 70 Wabash Avenue, Chicago, Illinois.

EATON, JAMES B., January 16th, 1907.
Purchasing Agent, Rochester Railway & Light Company, Rochester, New York.

EATON, W. M., October 17th, 1906.
Hodenpyl, Walbridge and Company, 7 Wall Street, New York, New York.

EGMAN, L. E., October 17th, 1906.
President, Pueblo (Colo.) Gas Company, 421 Chestnut Street, Philadelphia, Pennsylvania.

EGNER, FREDERICK, October 17th, 1906.
Consulting Gas Engineer, City of Fredericksburg (Va.), Box 902, Norfolk, Virginia.

EILBECK, A. B., October 17th, 1906.
Vice President and General Manager, Akron Gas Company, 59 East Market Street, Akron, Ohio.

ELBERT, V. L., October 17th, 1906.
Engineer and Superintendent, St. Paul Gas Light Company, St. Paul, Minnesota.

ELDER, DAVID, September 25th, 1907.
Superintendent Three Rivers Gas Company, Three Rivers, Michigan.

ELLES, EDWARD J., October 17th, 1906.
Secretary, New Charlotte Gas Company, Charlotte, Michigan.

ELLIOTT, ARTHUR H., October 17th, 1906.
Engineer-Chemist, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

ELLIOT, H. J., October 17th, 1906.
Sales Agent, Pittsburgh Coal Company, 205 Railway Exchange Building, Chicago, Illinois.

ELLIS, HARRY, September 25th, 1907.
Superintendent of Distribution, Public Service Corporation, Front and Cherry Streets, Camden, New Jersey.

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ELLIS, JOHN W., October 17th, 1906.
President and Manager, Providence Gas Company, 20 Market Square, Providence, Rhode Island.

ELLISON, B. F., October 17th, 1906.
General Manager, Superior Water, Light & Power Company, Superior, Wisconsin.

ELSTON, I. C., JR., October 17th, 1906.
President, Citizens Gas & Electric Company, Waterloo, Iowa.

ELY, ADDISON, October 17th, 1906.
President, Dover Rockaway Gas Company, Rutherford, New Jersey.

EMERY, JAMES A., October 17th, 1906.
Vice-President and General Manager, Birmingham Railway, Light & Power Company, 2100 First Avenue, Birmingham, Alabama.

ENGEL, FRANCIS, October 17th, 1906.
Superintendent Eliazbethtown Gas Light Company, Elizabeth, New Jersey.

ENGLISH, A. L., October 17th, 1906.
Manager, Citizens Gas & Electric Company, 26 Pearl Street, Council Bluffs, Iowa.

ENRIGHT, J. H., October 17th, 1906.
Manager, Frederick Gas & Electric Company, Frederick, Maryland.

EUSTACE, E. W., October 17th, 1906.
Superintendent Gas Department, Peoria Gas & Electric Company, 128 West Jefferson Street, Peoria, Illinois.

EUSTACE, JOHN H., October 17th, 1906.
Engineer, 157 Michigan Avenue, Chicago, Illinois.

EVANS, CHARLES H., October 17th, 1906.
Consulting and Contracting Engineer, 538 Postal Telegraph Building, Chicago, Illinois.

EVANS, GEORGE B., October 17th, 1906.
Care of Universal Engineering and Operating Company, 79 Wall Street, New York, New York.

EVANS, OWEN BROOKS, September 25th, 1907.
Engineer, The Peoples Gas Light Company, Manchester, New Hampshire.

EVES, PHILMER, October 1st, 1907.
Sales Agent, The Indianapolis Gas Company, Indianapolis, Indiana.

EYSENBACH, E. E., October 17th, 1906.
General Manager, Binghamton Gas Works, 40 Chenango Street, Binghamton, New York.

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FAIR, CAMPBELL W., October 17th, 1906.
Manager, Oskaloosa Light & Fuel Company, 216 West High Avenue, Oskaloosa, Iowa.

FALLER, G. W., October 17th, 1906.
Engineer of Distribution, Gas Department, Denver Gas & Electric Company, 2520 Emerson Street, Denver, Colorado.

FARR, ALBERT L., October 17th, 1906.
Engineering Department, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

FENDIG, ALBERT, October 17th, 1906.
President, Mutual Light & Water Company, Brunswick, Georgia.

FERGUSON, B. B., October 17th, 1906.
Superintendent, Portsmouth Gas Company, Box 39, Portsmouth, Virginia.

FERRIER, JAMES, October 17th, 1906.
President, Rome Municipal Gas Company, Rome, Georgia.

FERRIS, H. H., October 17th, 1906.
Superintendent of West End Works, Gas Department Hudson Division, Public Service Corporation of New Jersey, St. Paul and Duffield Avenues, Jersey City, New Jersey.

FEURTADO, RUSSELL S., October 17th, 1906.
Consulting Engineer, 503 Fisher Building, Chicago Illinois.

FIELD, ROY ALBRIGHT, October 17th, 1906.
Superintendent, Rome Gas, Electric Light & Power Company, 139 North James Street, Rome, New York.

FISHER, DAVID G., October 17th, 1906.
Superintendent Stations "B" and "E", Laclede Gas Light Company, Hotel Berlin, St. Louis, Missouri.

FITZ, ROBERT F., October 17th, 1906.
Consulting Gas Engineer, 890 Douglas Avenue, Elgin, Illinois.

FITZGERALD, JOHN H., October 17th, 1906.
Manager, Palestine Light, Heat & Power Company, Palestine, Texas.

FITZGERALD, LEONARD, October 17th, 1906.
Manager, Gas Department, Gary Heat, Light and Water Company, Gary, Indiana.

FLOYD, JAMES R., JR., October 17th, 1906.
Treasurer, Rossiter, MacGovern & Company, 90 West Street, New York, New York.

FOGG, OSCAR H., October 17th, 1906.
Engineer, Consolidated Gas Company, of New York, Box 12 Flushing, Long Island, New York.

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FOOTE, ROBERT DUMONT, September 25th, 1907.
President, Morristown Gas Light Company, Morristown, N. J.

FORBES, CHARLES, October 17th, 1906.
Manager and Superintendent, Ottawa Gas Company, 23 Sparks Street, Ottawa, Ontario, Canada.

FORD, A. H., October 17th, 1906.
Vice President, Birmingham (Ala.) Railway, Light & Power Company, 24 Broad Street, New York, New York.

FORDER, SAMUEL A., October 17th, 1906.
General Superintendent of Stations, Laclede Gas Light Company, St. Louis, Missouri.

FORSTALL, ALFRED E., October 17th, 1906.
Consulting Engineer, Secretary, Trustees Gas Educational Fund, 58 William Street, New York, New York.

FORSTALL, WALTON, October 17th, 1906.
Assistant Engineer of Distribution, Philadelphia Gas Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

FOSTER, STANLEY A., October 17th, 1906.
Superintendent, Gas Department Union Light, Heat and Power Company, Covington, Kentucky.

FOWLER, JOHN, October 17th, 1906.
Deily & Fowler, 39 Laurel Street, Philadelphia, Pennsylvania.

FOWLER, SAMUEL, J., October 17th, 1906.
Treasurer and Agent, Charlestown Gas & Electric Company, Charlestown, Massachusetts.

FOWLES, B. C., October 17th, 1906.
Manager, Pine Bluff Light & Water Company, Pine Bluff, Arkansas.

FOX, CLIFFORD S., October 17th, 1906.
Superintendent of Distribution, East River Gas Company, of Long Island City, Webster Avenue and East River, Long Island City, Long Island, New York.

FRANKLIN, JOHN, October 17th, 1906.
Superintendent of Distribution, Gas Department, Union Gas & Electric Company, Fourth and Plum Streets, Cincinnati, Ohio.

FRAZER, D. N., October 17th, 1906.
Treasurer and General Manager, Battle Creek Gas Company, 26 East Main Street, Battle Creek, Michigan.

FREESE, FRED W., October 17th, 1906.
Purchasing Agent and General Manager, Rochester (Ind.) Gas & Fuel Company, Fort Wayne, Indiana.

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*FRICK, JOHN A., October 17th, 1906, October 1st, 1907.
Superintendent Savannah Gas Co., Savannah, Georgia.

FROST, WILLIAM H., October 17th, 1906.
Secretary and General Manager, Detroit Gas & Coke Company, 1998 River Street, Detroit, Michigan.

FRUEAUFF, FRANK W., October 17th, 1906.
Vice-President and General Manager, Denver Gas & Electric Company, H. L. Doherty & Company, 60 Wall Street, New York, New York.

FULLERTON, GEORGE, October 17th, 1906.
Superintendent, Mohawk Gas Company, 6 Chestnut Street, Schenectady, New York.

FULWEILER, WALTER HERBERT, September 25th, 1907.
United Gas Improvement Company, 25th Ward Works, Richmond and Tioga Streets, Philadelphia, Pennsylvania.

FUNKHOUSER, E. M., October 17th, 1906.
President, Staunton Gas Company, Staunton, Virginia.

GAINWELL, R. H., October 17th, 1906.
Manager, Greensboro Electric Company, Greensboro, North Carolina.

GANSER, HERBERT H., October 17th, 1906.
Superintendent, Gas Company of Montgomery County, 109 East Main Street, Norristown, Pennsylvania.

GARDINER, WILLIAM HOWARD, October 17th, 1906.
Consulting Engineer, H. L. Doherty & Company, 60 Wall Street, New York, New York.

GARRARD, J. W., October 17th, 1906.
Vice-President, Ohio Fuel Supply Company, 52 West Gay Street, Columbus, Ohio.

GARTLAND, C. C., October 17th, 1906.
Superintendent and Chief Engineer, Sioux City Gas & Electric Company, 1112 Court Street, Sioux City, Iowa.

GARTLEY, WILLIAM H., October 17th, 1906.
Engineer of Philadelphia Gas Works, United Gas Improvement Company, Twenty-second and Filbert Streets, Philadelphia, Pennsylvania.

GAVIT, E. P., October 17th, 1906.
Secretary and Treasurer, Municipal Gas Company, 112 State Street, Albany, New York.

GENTRY, R. GARLAND, October 17th, 1906.
General Salesman, Denver Gas & Electric Company, 415 Seventeenth Street, Denver, Colorado.

* First date is that of election to membership in the Institute; second, that of transfer from Junior to Active membership.

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GEORGE, THOMAS L., October 17th, 1906.
General Agent, Philadelphia Gas Works, United Gas Improvement Company, Broad and Arch Streets, Philadephia, Pennsylvania.

GEROULD, CHARLES L., October 17th, 1906.
Manager, American Water Works & Guarantee Company, 1200 Bank for Savings, Pittsburg, Pennsylvania.

GIBBONS, P. H., October 17th, 1906.
General Foreman of Gas Distribution, Union Gas & Electric Company, 3107 Epworth Avenue, Cincinnati, Ohio.

GIBSON, WILLIAM, January 3rd, 1907.
President, Hamilton Gas Light Company, Box 152, Hamilton, Ontario, Canada.

GIFFORD, CHARLES H., October 17th, 1906.
Superintendent of Gas Works, New Bedford Gas & Edison Light Company, 214 South Water Street, New Bedford, Massachusetts.

GIFFORD, N. W., October 17th, 1906.
General Manager, East Boston Gas Company, 26 Central Square, East Boston, Massachusetts.

GILKYSON, JOSEPH R., September 25th, 1907.
General Agent, Gas and Electric Departments, Public Service Corporation, Camden, N. J.

GILLE, HENRY J., October 17th, 1906.
Manager, Commercial Department, St. Paul Gas Light Company, St. Paul, Minnesota.

GILLETT, MELVILLE October 17th, 1906.
Director, Gas Companies, Newark, Ohio.

GILLETTE, F. A., October 17th, 1906.
Treasurer and Manager Gas Light Company of Waverly, 340 Broad Stret, Waverly, New York.

GILLINGHAM, HUBERT D., October 17th, 1906.
Superintendent of Distribution, Gas Department Wilkes-Barre Gas & Electric Company, 27 North Main Street, Wilkes-Barre, Pennsylvania.

GIMPER, E. H., October 17th, 1906.
General Manager, Spokane Falls Gas Light Company, Spokane, Washington.

GIMPER, JOHN, October 17th, 1906.
Engineer and Superintendent, Galveston Gas Company, 32nd Street and Avenue D, Galveston, Texas.

GLASGOW, ARTHUR GRAHAM, October 17th, 1906.
Humphreys & Glasgow, 38 Victoria Street, London, S .W., England.

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GLASS, SHELDON J., October 17th, 1906.
Vice-President and General Manager, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

GODLEY, WALTER, October 17th, 1906.
Secretary and Treasurer, The American Gas Company, 222 South Third Street, Philadelphia, Pennsylvania.

GOLDEN, JOHN W., October 17th, 1906.
Vice-President, Savannah Gas Company, Box 426, Savannah, Georgia.

GOODNOW, GEORGE F., October 17th, 1906.
General Manager, North Shore Gas Company, Waukegan, Illinois.

GOODWIN, JAMES, October 17th, 1906.
Manager, Power Transit Light Company, 1918 H Street, Bakersfield, California.

GORTON, JOHN C., October 17th, 1906.
Consulting Engineer, 210 Olive Street, Warren, Ohio.

GOUDY, W. R., October 17th, 1906.
Assistant Secretary and Assistant Treasurer, Syracuse Lighting Company, Syracuse, New York.

GOULD, JOHN A., October 17th, 1906.
Assistant Engineer, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

GOULD, VERNON K., October 17th, 1906.
Manager, Bangor Gas Light Company, Bangor, Maine.

GRAEFF, HAROLD W., October 17th, 1906.
Superintendent, Kansas City (Mo.) Gas Company, 219 West Armour Boulevard, Kansas City, Missouri.

GRAF, CARL H., October 17th, 1906.
General Manager, Indianapolis Gas Company, Majestic Building, Indianapolis, Indiana.

GRAHAM, L. C., October 17th, 1906.
Manager, Winona Gas Light & Coke Company, 115 Center Street, Winona, Minnesota.

GRAHAM, MALCOLM M., October 17th, 1906.
Secretary and Treasurer, New Amsterdam Gas Company, 131 East Twenty-third Street, New York.

GRANT, ROBERT, June 19th, 1907.
Treasurer, Boston Consolidated Gas Company, Boston, Massachusetts.

GRAVES, HENRY C., October 17th, 1906.
Vice-President, Dayton Gas Light & Coke Company, Dayton, Ohio.

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GREACEN, W., JR., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 538 Washington Street, Hoboken, New Jersey.

GREEN, JAMES, October 17th, 1906.
President, Laclede Christy Clay Products Company, Sulphur and Manchester Avenues, St. Louis, Missouri.

GREENOUGH, MALCOLM S., October 17th, 1906.
President and General Manager, Cleveland Gas Light & Coke Company, 421 Superior Street, Cleveland, Ohio.

GREGORY, JOHN M., October 17th, 1906.
Superintendent, Sault Ste. Marie Gas & Electric Company, Sault Ste. Marie, Michigan.

GREIM, O. F., October 17th, 1906.
Superintendent, Milwaukee Coke & Gas Company, Lock Box 820, Milwaukee, Wisconsin.

GRIBBEL, JOHN, October 17th, 1906.
President, Coatesville (Penn.) Gas Company, 1513 Race Street, Philadelphia, Pennsylvania.

GRIFFIN, JOHN F., January 3rd, 1907.
Superintendent, Dowagiac Gas and Fuel Company, Dowagiac, Michigan.

GRISWOLD, R. G., October 17th, 1906.
Member of Engineering Corps, Denver Gas & Electric Company, 405 Seventeenth Street, Denver, Colorado.

GROSS, ALFRED H., October 17th, 1906.
President, Sterling (Ill.) Gas & Electric Company, 702 La Salle Street, Chicago, Illinois.

GUFFEY, JOSEPH F., October 17th, 1906.
General Manager, The Philadelphia Company, 435 Sixth Avenue, Pittsburg, Pennsylvania.

GULDLIN, OLAF N., October 17th, 1906.
President, Western Gas Construction Company, 2306 Fairfield Avenue, Fort Wayne, Indiana.

GUTSCHE, EDWARD J., October 17th, 1906.
Chemist, St. Paul Gas Works, St. Paul, Minnesota.

HAASE, EWALD, October 17th, 1906.
Secretray and Treasurer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

HAFTENKAMP, JOSEPH P., October 1st, 1907.
Assistant-Superintendent, Rochester Railway and Light Company, Rochester, N. Y.

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HAGERTY, J. H., October 17th, 1906.
Superintendent, Americus Illuminating & Power Company, Americus, Georgia.

HAGUE, WILLIAM, October 17th, 1906.
Superintendent, Forest Gas Company, Tidioute, Pennsylvania.

HAINES, JANSEN, October 17th, 1906.
Manager, Des Moines Gas Company, 417 Locust Street, Des Moines, Iowa.

HALL, A. H., October 17th, 1906.
Assistant Secretary and Superintendent of Distribution, Central Union Gas Company and Northern Union Gas Company, 350 Alexander Avenue, New York, New York.

HAMMATT, CLARENCE S., October 17th, 1906.
Vice-President, Consolidated Engineering Company, and Florida Electric Company, Jacksonville, Florida.

HAMMON, WILLIAM H., October 17th, 1906.
President, Hope Engineering & Supply Company, 902 Farmers Bank Building, Pittsburg, Pennsylvania.

HANLON, J. P., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 109 Montgomery Street, Jersey City, New Jersey.

HANTZMON, H. M., October 17th, 1906.
Superintendent, Alexandria Gas Works, Charlottsville, Virginia.

HARDICK, CHARLES F., October 17th, 1906.
District Superintendent and Agent, United Gas Improvement Company, 4015 Main Street, Manayunk, Philadelphia, Pennsylvania.

HARPER, GEORGE H., October 17th, 1906.
Gas Engineer, Altoona, Pa.

HARRINGTON, A. S., October 17th, 1906.
Assistant Superintendent South Station, Peoples Gas Light & Coke Company, 25th & Loomis Streets, Chicago, Illinois.

HARROP, H. B., October 17th, 1906.
Societe Anonyme du Gas, Rio de Janeiro, Brazil.

HART, WILLIAM F., October 17th, 1906.
General Manager, Washington Gas Light Company, Washington, District of Columbia.

HARTMAN, WILLIAM E., October 17th, 1906.
Superintendent of Joliet Plant, Western United Gas & Electric Company, Joliet, Illinois.

HARTZELL, A. C., October 17th, 1906.
Treasurer, Greenville Natural Gas Company, Canal Street, Greenville, Pennsylvania.

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HATHAWAY, E. C., October 17th, 1906.
Vice-President and General Manager, City Gas Company, of Norfolk, 82 Plume Street, Norfolk, Virginia.

HAY, ALBERT E., October 17th, 1906.
Vice-President and General Manager, Oberlin Gas & Electric Company, Oberlin, Ohio.

HAYWARD, THOMAS J., October 17th, 1906.
Bartlett, Hayward & Company, Baltimore, Maryland.

HEDGES, WILLIAM C., October 17th, 1906.
Secretary and Superintendent, Mansfield Gas Light Company, Mansfield, Ohio.

HELLEN, FRANK, January 16th, 1907.
Superintendent Gas Department, Rochester Railway & Light Company, Rochester, New York.

HELLEN, JOHN, October 17th, 1906.
Superintendent of Distribution, Grand Rapids Gas Light Company, 109 North Ottawa Street, Grand Rapids, Michigan.

HELME, WILLIAM E., October 17th, 1906.
Director several Gas Companies, 1339 Cherry Street, Philadelphia, Pennsylvania.

HESSENBRUCH, GEORGE S., October 17th, 1906.
Chief Draftsman, Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

HIGGINS, HENRY C., October 17th, 1906.
Vice-President and Manager, Lee County Lighting Company, Dixon, Illinois.

HILLEKE, AUGUST F., October 17th, 1906.
Superintendent, Semet Solvay Company, Dunbar, Pennsylvania.

HINDS, O. H., January 3rd, 1907.
Manager, Le Mars Gas Company, Le Mars, Iowa.

HINTON, W. F., October 17th, 1906.
Greensboro Electric & Gas Company, 215 East Market Street, Greensboro, North Carolina.

HIRAMATSU, SUYEKUCHI, October 17th, 1906.
Chief Engineer, Tokio Gas Company, Nishikicho, Kanda, Tokio, Japan.

HOFFMAN, HOWARD, October 1st, 1907.
Engineer South Bend and Mishawaka Gas Company, South Bend, Indiana.

HOFMANN, G. MAX, October 17th, 1906.
General Superintendent, Fort Wayne Gas Company, Fort Wayne, Indiana.

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HOFMANN, LOTHAR, October 17th, 1906.
Assistant Engineer, Fort Wayne Gas Company, 2205 Broadway, Fort Wayne, Indiana.

HOLDEN, THOMAS F., October 17th, 1906.
Superintendent East Station, Washington Gas Light Company, 12th and M Streets, S. E., Washington, District of Columbia.

HOLMAN, C. L., October 17th, 1906.
Secretary, The Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

HOLMES, RUFUS E., October 17th, 1906.
President, Winsted Gas Company, 55 High Street, Winsted, Connecticut.

HOLZER, EDWIN G., October 17th, 1906.
Superintendent, Easton Gas & Electric Company, 228 North Front Street, Easton, Pennsylvania.

HORTON, THOMAS O., October 17th, 1906.
Secretary and Manager, New York & Richmond Gas Company, 264 Bay Street, Stapleton, New York.

HOUGH, DAVID LEAVITT, October 17th, 1906.
President, United Engineering & Contracting Company, The New York Tunnel Company, 32 East 33rd Street, New York, New York.

HOWARD, ABRAM C., October 17th, 1906.
Assistant Superintendent, 25th Ward Works, United Gas Improvement Company, Richmond and Tioga Streets, Philadelphia, Pennsylvania.

HOWARD, CHARLES A., October 17th, 1906.
President, Aberdeen Gas Company, Aberdeen, South Dakota.

HOWARD, J. B., October 17th, 1906.
President, Galena Light Company, Galena, Illinois.

HOYT, HARRY B., October 17th, 1906.
General Manager, Jacksonville Gas Company, 18 West Forsythe Street, Jacksonville, Florida.

HOYT, WILLIAM G., October 17th, 1906.
President, The Standard Gas Light Company, 61 East 59th Street, New York, New York.

HUBER, FRANK, October 17th, 1906.
Superintendent, Louisville Gas Company, Louisville, Kentucky.

HULSWIT, FRANK T., October 17th, 1906.
Officer and Director several Gas Companies, Child, Hulswit & Company, 411 Michigan Trust Building, Grand Rapids, Michigan.

HUMPHREYS, ALEXANDER C., October 17th, 1906.
President, Buffalo (N. Y.) Gas Company, and Senior Member Humphreys & Glasgow, 31 Nassau Street, New York, New York.

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HUMPHREYS, C. J. R., October 17th, 1906.
Vice-President, Lawrence Gas Company, Lawrence, Massachusetts.

HUMPHREYS, HENRY M., October 17th, 1906.
Assistant Superintendent, West Side Works, Milwaukee Gas Light Company, 92 Eighteenth Street, Milwaukee, Wisconsin.

HUMPHREYS, J. J., JR., October 17th, 1906.
General Manager, Brooklyn Borough Gas Company, Sheepshead Bay Road and West Fifth Street, Coney Island, New York.

HUNT, H. R., October 17th, 1906.
Superintendent, Peoples Gas Light & Coke Company, Ninety-sixth Street and Erie Avenue Station, Chicago, Illinois.

HURLBURT, A., October 17th, 1906.
Assistant Engineer, Kansas City (Mo.) Gas Company, Third and Gilles Streets, Kansas City, Missouri.

HUNTTING, J. R., January 3rd, 1907.
1095 Perry Street, Chicago, Illinois.

HUTCHINGS, JAMES T., June 19th, 1907.
Assistant General Manager, Rochester Railway and Light Company, Rochester, New York.

HUTCHINSON, F. R., October 17th, 1906.
Commercial Agent, South Jersey Division, Public Service Corporation of New Jersey, 418 Federal Street, Camden, New Jersey.

HYDE, GUSTAVUS A., October 17th, 1906.
Gas Engineer (Retired), 285 East Forty-sixth Street, Cleveland, Ohio.

HYDE, HENRY H., October 17th, 1906.
Secretary and Manager, Racine Gas Light Company, 305 Sixth Street, Racine, Wisconsin.

IRWIN, HENRY, October 17th, 1906.
Treasurer, Consolidated Gas Company of New Jersey, 196 Union Avenue, Long Branch, New Jersey.

JACKSON, WALTER M., October 17th, 1906.
General Gas & Electric Engineer, 10 Oliver Street, Stamford, Connecticut.

JACKSON, WILLIAM B., October 17th, 1906.
Consulting Engineer, D. C. and W. B. Jackson, 508 Commercial National Bank Building, Chicago, Illinois.

JAMES, F. M., October 17th, 1906.
General Accountant, Western United Gas & Electric Company, Aurora, Illinois.

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JAMES, ROBERT C., October 1st, 1907.
Assistant General Auditor, United Gas Improvement Company, Philadelphia, Pennsylvania.

JELIFFE, C. N., October 17th, 1906.
Auditor, American Light & Traction Company, 40 Wall Street, New York, New York.

JENKS, R. J., October 17th, 1906.
Superintendent, Northwestern Gas Light & Coke Company, Evanston, Illinois.

JOHNS, L. B., October 17th, 1906.
Superintendent and Manager, Dedham and Hyde Park Gas & Electric Light Company, Hyde Park, Massachusetts.

JOHNSON. A. H., October 17th, 1906.
Bookkeeper, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

JOHNSON, HERBERT GILMORE, October 17th, 1906.
Superintendent, of Gas Works, Utica Gas & Electric Company, 16 Taylor Avenue, Utica, New York.

JOHNSTON, MERVYN E., October 17th, 1906.
Auditor, Universal Engineering and Operating Company, 79 Wall Street, New York, New York.

JONES, EDWARD C., October 17th, 1906.
Chief Engineer Gas Department, California Gas & Electric Corporation and San Francisco Gas & Electric Company, 925 Franklin Street, San Francisco, California.

JONES, THOMAS CLIVE, October 17th, 1906.
President, Delaware Gas Company, 6 West Winter Street, Delaware, Ohio.

JONES, THOMAS J., January 3rd, 1907.
Manager, El Paso Gas & Electric Company, El Paso, Texas.

JOURDAN, EDWARD R., October 17th, 1906.
Assistant General Superintendent of Mains & Services, Consolidated Gas Company, of New York, 4 Irving Place, New York, New York.

JOURDAN, JAMES, H., October 17th, 1906.
Chief Engineer, Brooklyn Union Gas Company, Brooklyn, New York.

KANE, JOSEPH P., January 3rd, 1907.
Superintendent, Westchester Lighting Company, 101 North Main Street, Port Chester, New York.

KEENE, ALFRED M., October 1st, 1907.
Auditor, Westchester Lighting Company, Mount Vernon, New York.

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KEILLOR, JOHN D., January 3rd, 1907.
Engineer and Manager, Hamilton Gas Light Company, Box 152, Hamilton, Ontario, Canada.

KELLER, C. M., October 17th, 1906.
Gas Light and Coke Company, 312 Washington Street, Columbus, India.

KELLEY, FREDERICK W., October 17th, 1906.
Secretary and Manager, Peoples Light Company, Davenport, Iowa.

KELLOGG, LEONARD L., October 17th, 1906.
Vice-President and Manager, Sioux City Gas & Electric Company, Sioux City, Iowa.

KELLOGG, R. M., October 17th, 1906.
Superintendent, Lowell Gas Light Company, Lowell, Massachusetts.

KELSEY, LOUIS D., January 3rd, 1907.
Manager, Brookfield Gas & Electric Company, Brookfield, Missouri.

KEMPER, LUDWIG, October 17th, 1906.
Treasurer and Manager, Albert Lea Light & Power Company, West Clark Street, Albert Lea, Minnesota.

KEMPF, JOHN, JR., October 17th, 1906.
Gas Engineer, Utah Light & Railway Company, Box 52, Salt Lake City, Utah.

KENAN, NORMAN G., October 17th, 1906.
President, The Union Gas & Electric Company, Fourth and Plum Streets, Cincinnati, Ohio.

KENNEDY, JAMES, September 25th, 1907.
Agent, Gas and Electric Departments Public Service Corporation, 591 Spring Street, West Hoboken, New Jersey.

KENNEDY, JAMES S., October 17th, 1906.
Superintendent, Standard Gas Light Company's Works, Foot of East 115th Street, New York, New York.

KENNEDY, JOHN PENDLETON, October 1st, 1907.
Superintendent, Cambridge Gas Light Company, East Cambridge, Massachusetts.

KEPPELMAN, JOHN H., October 17th, 1906.
Superintendent, Consumers Gas Company, 20 North Fifth Street, Reading, Pennsylvania.

KERSTING, ALBERT F., October 17th, 1906.
Superintendent, Mobile Gas Company, Box 234, Mobile, Alabama.

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KILGOUR, J. H., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 183 Main Street, Passaic, N. J.

KIMBALL, ROGER N., October 17th, 1906.
Vice-President and General Manager, Kenosha Gas & Electric Company, 210 Wisconsin Street, Kenosha, Wisconsin.

KINCAID, H. E., October 17th, 1906.
Manager, Citizens Gas Light Company, Jackson, Tennessee.

KIRCHER, HARRY B., January 3rd, 1907.
Superintendent, Belleville District, St. Clair County Gas and Electric Company, Belleville, Illinois.

KIVLEN, J. FRANK, October 17th, 1906.
Foreman, Utica Gas & Electric Company, Utica, New York.

KLUMPP, JOHN BARTLEMAN, October 17th, 1906.
Inspecting Engineer, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pa.

KNAPP, AMOS, M., October 17th, 1906.
Distribution Foreman, Peekskill Lighting & Railway Company, Peekskill, New York.

KNAPP, ISAAC N., October 17th, 1906.
Gas Engineer, Box 496 Ardmore, Pennsylvania.

KNIGHT, CHARLES S., October 17th, 1906.
President, Fort Wayne, Indiana.

KNIGHT, J. J., October 17th, 1906.
Vice-President, Kalamazoo Gas Company, 123 West Street, Kalamazoo, Michigan.

KNOWLES, WILLIAM P., October 17th, 1906.
Superintendent, Richmond City Gas Works, 2606 Grove Avenue, Richmond, Virginia.

KOINER, C. W., October 17th, 1906.
General Superintendent and Engineer, Los Angeles Gas and Electric Company, Los Angeles, California.

KRAFT, R. P., October 17th, 1906.
Superintendent West Side Works, Milwaukee Gas Light Company, Milwaukee, Wisconsin.

LAMSON, CHARLES DUDLEY, October 17th, 1906.
President and General Manager, Worcester Gas Light Company, 240 Main Street, Worcester, Masachusetts.

LAMSON, WILLIAM O., Jr., January 3rd, 1907.
Manager, Chester County Gas Company, West Chester, Pennsylvania.

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LANE, FRANK K., October 17th, 1906.
Manager, Richmond Light, Heat & Power Company, Richmond, Indiana.

LANE, FREDERICK K., October 17th, 1906.
General Manager and Treasurer, Seattle Lighting Company, Seattle, Washington.

LANE, R. M., October 17th, 1906.
Care Crescent Athletic Club of Brooklyn, 129 Pierrepont St., Brooklyn, N. Y.

LATHROP, ALANSON P., October 17th, 1906.
Vice-President and Treasurer, American Light & Traction Company, 40 Wall Street, New York, New York.

LATTA, M. NISBET, October 17th, 1906.
Engineer, H. Mueller Manufacturing Company, 254 Canal Street, New York, New York.

LAW, A. R., October 17th, 1906.
Vice-President Consolidated Railway and Light Company, Suite 1511, 42 Broadway, New York, New York.

LAWLOR, R. H., October 17th, 1906.
Superintendent Gas Department, Citizens Gas & Electric Company, East Fourth Street, Waterloo, Iowa.

LAWRENCE, W. F., October 17th, 1906.
Superintendent Ravenswood Works, New Amsterdam Gas Company, Ravenswood, Long Island City, New York.

LAYTON, MILES B., October 17th, 1906.
Superintendent, Manufacturers Light & Heat Company, 215 Farmers Bank Building, Pittsburg, Pennsylvania.

LEA, HENRY I., October 17th, 1906.
Gas Engineer, 616 Rookery Building, Chicago, Illinois.

LEARNED, CHARLES A., October 17th, 1906.
Superintendent and Manager, Meriden Gas Light Company, 40 Colony Street, Meriden, Connecticut.

LEARNED, WALDO A., October 17th, 1906.
General Superintendent, Newton and Watertown Gas Light Company, 2 Jewett Street, Newton, Masachusetts.

LEBARON, L. W., October 17th, 1906.
Manager and Superintendent, Citizens Gas & Coke Company, Grand Junction, Colorado.

LEE, LAWRENCE RUST, October 17th, 1906.
Treasurer and General Manager, Charlestown Gas & Water Company, and Martinsburg Gas Company, Shepherdstown, West Virginia.

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LELAND, F. W., January 3rd, 1907.
Superintendent, Federal Gas Company, Boulder, Colorado.

LELAND, G. B., October 17th, 1906.
General Superintendent, Stamford Gas & Electric Company, 196 Atlantic Street, Stamford, Connecticut.

LEONARD, CHARLES F., October 17th, 1906.
Superintendent Fall River Gas Company, 62 North Main Street, Fall River, Massachusetts.

LETANG, B. E., October 17th, 1906.
Proprietor, Jackson Gas Light Company, Jackson, California.

LEWIS, WILLIAM MORGAN, October 17th, 1906.
General Manager, Rockville Gas Company, 17 Park Street, Rockville, Connecticut.

LIGHT, EDWARD H., October 17th, 1906.
Superintendent of Distribution, Dayton Gas Light & Coke Company, 203 East First Street, Dayton, Ohio.

LIGHT, GEORGE, October 17th, 1906.
Assistant Superintendent, Dayton Gas Light & Coke Company, Dayton, Ohio.

LILLIE, LEWIS, October 17th, 1906.
Fourth Vice-President and Treasurer, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

LINDEROTH, ALFRED H., October 17th, 1906.
Draftsman, St. Paul Gas Light Company, 441 Mt. Ida Street, St. Paul, Minnesota.

LINDSAY, ROBERT, October 17th, 1906.
Chemist, New Bedford Gas & Edison Light Company, 374 Orchard Street, New Bedford, Massachusetts.

LINDSTEDT, JULIUS, October 17th, 1906.
Secretary and Manager, Manitowoc Gas Light Company, 808 Washington Street, Manitowoc, Wisconsin.

LINTON, SAMUEL E., Jr., October 17th, 1906.
Superintendent and Agent, Vicksburg Gas Company, Vicksburg, Mississippi.

LITTLE, F. W., October 17th, 1906.
President, Springfield (Mo.) Gas & Electric Co., 1901 Emerson Avenue, South Minneapolis, Minnesota.

LITTLEHALES, THOMAS G., October 17th, 1906.
Operating Engineer, United Coke & Gas Company (New York, New York). Box 351, Camden, New Jersey.

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LITTLETON, A. W., October 17th, 1906.
Care of London City and Midland Bank, Ltd., London, E. C., England.

LLOYD, ALFRED G., October 17th, 1906.
Vice-President, Adrian (Mich.) Gas Company, 860 Greenwood Avenue, Detroit, Michigan.

LLOYD, ERNEST F., October 17th, 1906.
President and Treasurer, Adrian (Mich.) Gas Company, 860 Greenwood Avenue, Detroit, Michigan.

LOCKWOOD, Jos. E., January 3rd, 1906.
General Manager, Toledo Gas, Electric & Heating Company, 2017 Glenwood Avenue, Toledo, Ohio.

LOGAN, JOHN D., October 17th, 1906.
Vice-President Greenpoint Gas Light Company, P. O. Box 6, Station G., Brooklyn, New York.

LOICHOT, JOSEPH L., October 17th, 1906.
Manager, Canton Gas Light & Coke Company, 130 East Fourth Street, Canton, Ohio.

LOOMIS, BURDETT, October 17th, 1906.
Treasurer, Northern Connecticut Light & Power Company, Windsor Locks, Connecticut.

LORD, R. S., October 17th, 1906.
Secretary and Treasurer, Hope Engineering & Supply Company, 902 Farmers Bank Building, Pittsburg, Pennsylvania.

LORENZ, JOHN, October 17th, 1906.
Gas Engineer, 708 Amite Street, Jackson, Mississippi.

LOW, D. W., October 17th, 1906.
Superintendent, Alliance Gas & Electric Company, Alliance, Ohio.

LUTHER, F. E., October 17th, 1906.
Superintendent, Ogden Gas Company, Hawthorne Avenue and Willow Street, Chicago, Illinois.

LUTHER, WILLIAM J., October 17th, 1906.
Superintendent, Attleboro Gas Light Company, 19 Dunham Street, Attleboro, Massachusetts.

LYNN, JAMES T., October 17th, 1906.
President, National Gas, Electric Light & Power Company, 402 Union Trust Building, Detroit, Michigan.

LYNN, JOHN R., October 17th, 1906.
Superintendent, Huntsville Gas Company, 214 West Clinton Street, Huntsville, Alabama.

LYON, CHAS. LUMSDEN, October 1st, 1907.
Cadet Engineer, Savannah Gas Company, Savannah, Georgia.

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LYONS, B. F., October 17th, 1906.
Manager, Beloit Water, Gas & Electric Company, Beloit, Wisconsin.

MCADAM, BRYCE, October 17th, 1906.
Superintendent of Distribution, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wis.

MCCALLUM, J. N., October 17th, 1906.
Auditor, Citizens Gas & Electric Company, Waterloo, Iowa.

MCCARTER, THOS. N., September 25th, 1907.
President, Public Service Corporation, Newark, N. J.

MCCLARY, N. A., October 17th, 1906.
President, Northwestern Gas Light Company, 184 La Salle Street, Chicago, Illinois.

MCCORKINDALE, WILLIAM J., October 17th, 1906.
General Manager, Marquette County Gas & Electric Company, Ishpeming, Michigan.

MCDONALD, DONALD, October 17th, 1906.
President, Kentucky Heating Company, 2000 Seventh Street, Louisville, Kentucky.

*MCDONALD, DONALD, October 17th, 1906; October 1, 1907.
Director, Erie (Penn.) Gas Company, 51 Lancaster Street, Albany, New York.

MCDONALD, WILLIAM, October 17th, 1906.
Vice-President Erie (Penn.) Gas Company, 51 Lancaster Street, Albany, New York.

MCDOWELL, G. C., January 3rd, 1907.
General Manager, Kansas Natural Gas Company, Farmers' Bank Building, Pittsburg, Pennsylvania.

MCGREGOR, WILLIAM, October 17th, 1906.
Secretary and General Manager, Pawtucket Gas Company, 231 Main Street, Pawtucket, Rhode Island.

MCILHENNY, JAMES S., October 17th, 1906.
Engineer, Washington Gas Light Company, Washington, District of Columbia.

MCILHENNY, JOHN, October 17th, 1906.
Consulting Engineer, Washington (D. C.) Gas Light Company, 1339 Cherry Street, Philadelphia, Pennsylvania.

MCILHENNY, JOHN D., October 17th, 1906.
President, Gas Company of Montgomery County, Norristown, Pennsylvania, 1339 Cherry Street, Philadelphia, Pennsylvania.

* First date is that of election to membership in the Institute; second, that of transfer from Associate to Active Membership.

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McKAY, WILLIAM E., October 17th, 1906.
Engineer of Construction, Boston Consolidated Gas Company, New England Gas and Coke Company, 24 West Street, Boston, Massachusetts.

McKEE, G. W., October 17th, 1906.
Care of Peoples' Gas Light and Coke Company, Michigan Avenue and Adams Street, Chicago, Illinois.

McKENZIE, W. H., October 17th, 1906.
Superintendent, Wyandotte Gas Company, Sixth Avenue, Kansas City, Kansas.

McLAUGHLIN, R. A., October 17th, 1906.
General Superintendent, Galesburg Railway & Light Company, Galesburg, Illinois.

McLEAN, GEORGE, October 17th, 1906.
President and Manager, Key City Gas Company, 669 Main Street, Dubuque, Iowa.

McMILLIN, EMERSON, October 17th, 1906.
President, American Light & Traction Company, 40 Wall Street, New York, New York.

MACBETH, A. B., October 17th, 1906.
Engineer, Kansas City (Mo.) Gas Company, Kansas City, Missouri.

MACBETH, GEORGE T., October 17th, 1906.
Engineer, Gas Department, Westchester Lighting Company, First Avenue and First Street, Mount Vernon, New York.

MACDONALD, B. J., October 17th, 1906.
Secretary, Goshen Illuminating Company, 421 Grand Street, Newburgh, New York.

MACDONALD, GEORGE, October 17th, 1906.
President and General Manager, Nassau and Suffolk Lighting Company of Freeport, New York. 308 West 81st Street, New York, New York.

MACKAY, CHARLES, October 17th, 1906.
Superintendent, Gas Works, Watertown Gas & Electric Company, Watertown, Wisconsin.

MACMILLAN, ROBERT, October 17th, 1906.
Secretary, Kansas City (Mo.) Gas Company, 912 Grand Avenue, Kansas City, Missouri.

MACY, CARLTON, October 17th, 1906.
President and General Manager, Queens Borough Gas & Electric Company, Far Rockaway, New York.

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MAGEE, CHARLES A., October 17th, 1906.
Auditor, Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

MAINLAND, SINCLAIR, October 17th, 1906.
Treasurer, Continental Public Utilities Company, Oshkosh, Wisconsin.

MAINLAND, WILLIAM, October 17th, 1906.
President, Continental Public Utilities Company, Oshkosh, Wisconsin.

MALONE, M. E., October 17th, 1906.
Superintendent Gas Department, Denver Gas & Electric Company, 405 Seventeenth Street, Denver, Colorado.

MALONEY, ANDREW P., October 1st, 1907.
President, Treasurer and General Manager, City Gas Light Company, Ocean City, N. J. 1504 Tioga Street, Philadelphia, Pennsylvania.

MANIER, ROBERT W., October 17th, 1906.
Treasurer, Binghampton Gas Works, 40 Chenango Street, Binghampton, New York.

MANN, HOWARD E., October 17th, 1906.
Superintendent of Works, Cleveland Gas Light & Coke Company. 421 Superior Avenue, N. E., Cleveland, Ohio.

MANSUR, JOHN H., October 17th, 1906.
President, Consolidated Schuylkill Gas Company, of Phœnixville, Pa., 436 Walnut Street, Royersford, Pennsylvania.

MARANI, VIRGIL G., October 17th, 1906.
Civil and Consulting Engineer, Cleveland Gas Light & Coke Company, 421 Superior Avenue, N. E., Cleveland, Ohio.

MARKHUS, O. G. F., October 17th, 1906.
Engineer, Wm. & S. Mainland, Oshkosh, Wisconsin.

MARKLEY, JOSEPH, October 17th, 1906.
Vice-President, South Shore Gas & Electric Company, of Hammond, Indiana, 621 New York Life Building, Chicago, Illinois.

MARKS, R. J., October 17th, 1906.
Superintendent, City Gas Company, Norfolk, Virginia.

MARKS, WM. D., October 17th, 1906.
Consulting Engineer, 623 Park Row Building, New York, New York.

MARPLE, WILLIAM MCKELVEY, October 17th, 1906.
Chief Engineer, Scranton Gas & Water Company, 423 Jefferson Avenue, Scranton, Pennsylvania.

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MARSHALL, F. L., October 17th, 1906.
Portsmouth Gas Company, 111 Middle Street, Portsmouth, Virginia.

MARSHALL, W. D., October 17th, 1906.
General Superintendent, New Orleans Gas Company, 1643 Perdido Street, New Orleans, Louisiana.

MARSHALL, WILLIAM H., October 17th, 1906.
Assistant Secretary, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

MARTIN, FREEMAN DRAKE, October 17th, 1906.
Superintendent and Treasurer, Fort Scott Gas & Electric Company, 111 East Wall Street, Fort Scott, Kansas.

MARTIN, JOHN, October 17th, 1906.
President, California Central Gas & Electric Company, 925 Franklin Street, San Francisco, California.

MARTIN, J. H. T., October 17th, 1906.
President, Fayetteville (N. C.) Gas & Electric Company, 32 Liberty Street, New York, New York.

MASON, JOHN T., October 17th, 1906.
Superintendent Third Ward Works, Milwaukee Gas Light Company, Milwaukee, Wisconsin.

MAXON, J. H., October 17th, 1906.
Manager, Gallipolis Gas & Coke Company, Athens, Georgia.

MAYERS, J. ALEX., October 17th, 1906.
Gas Engineer, 56 Pine Street, New York, New York.

MEEKER, CHARLES A., October 17th, 1906.
Vice-President and Treasurer, Indiana Gas & Electric Company, 1206 State Life Building, Indianapolis, Indiana.

MELICK, THOS., September 25th, 1907.
Superintendent, Gas Department Public Service Corporation, Plainfield, New Jersey.

MEGINNISS, E. B., October 17th, 1906.
Manager, Dallas Gas Company, 421 Main Street, Dallas, Texas.

MERCHANT, O. A., Jr., January 3rd, 1907.
Manager, Cape May Illuminating Company, Cape May, New Jersey.

MERRIFIELD, L. L. October 17th, 1906.
Consulting Engineer, 269 Front Street, Toronto, Ontario, Canada.

MERRITT, ALBERT H., October 17th, 1906.
Manager, Niagara Falls (N. Y.) Gas & Electric Light Company, Niagara Falls, New York.

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MERRITT, W. H., October 17th, 1906.
General Superintendent, Lebanon Gas & Fuel Company, Lebanon, Pennsylvania.

MIDDLETON, ROBERT L., October 17th, 1906.
General Manager and Superintendent, Georgetown Gas Light Company, 1118 Twenty-ninth Street, Washington, District of Columbia.

MILLARD, FREDERICK CHAS., September 25th, 1907.
Superintendent of Gas Manufacture, Los Angeles Gas and Electric Company, 645 South Hill Street, Los Angeles, California.

MILLER, ALTEN S., October 17th, 1906.
Vice-President and General Manager, Consolidated Gas, Electric Light & Power Company, 100 West Lexington Street, Baltimore, Maryland.

MILLER, CARROLL, October 17th, 1906.
Consulting Engineer, 435 Sixth Avenue, Pittsburg, Pennsylvania.

MILLER, C. O. G., October 17th, 1906.
President, Pacific Lighting Company, 502 California Street, San Francisco, California.

MILLER, E. E., October 17th, 1906.
Manager New Business Department, Union Gas & Electric Company, Fourth and Plum Streets, Cincinnati, Ohio.

MILLER, IRA ABBOTT, October 17th, 1906.
Assistant Secretary, Treasurer and Superintendent. Colorado Springs Light & Power Company, 107 East Kiowa Street, Colorado Springs, Colorado.

MILLER, ROBERT S., October 17th, 1906.
Manager, Jackson County Light, Heat & Power Company, Independence, Missouri.

MILLER, R. W., October 17th, 1906.
Manager, Durham Light and Power Company, Durham, North Carolina.

MILLER, THOMAS DAVID, October 17th, 1906.
Manager, New Orleans Gas Light Company, 201 Baronne Street, New Orleans, Louisiana.

MILLER, V. A., October 1st, 1907.
Superintendent, Canandaigua Gas Light Company, Canandaigua, New York.

MILLER, WILLIAM A., October 17th, 1906.
General Manager, Union Gas & Electric Company, Fourth and Plum Streets, Cincinnati, Ohio.

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MILLER, WILLIAM B., October 17th, 1906.
Superintendent Gas Department, Birmingham Railway, Light & Power Company, 1310 North 24th Street, Birmingham, Alabama.

MILNE, DAVID S., October 17th, 1906.
Manager, Ottumwa Gas Light, Heat & Power Company, Ottumwa, Iowa.

MILSTED, WILLIAM N., October 17th, 1906.
Secretary, American Meter Company, 561 West 47th Street, New York, New York.

MITCHELL, KERR M., October 17th, 1906.
General Manager, St. Joseph Gas Company, Eighth and Francis Streets, St. Joseph, Missouri.

MOCKETT, W. E., October 17th, 1906.
Associated with Lloyd Construction Company, Detroit, Michigan.

MOLONY, MARTIN, October 17th, 1906.
District Superintendent, United Gas Improvement Company, 3650 Market Street, Philadelphia, Pennsylvania.

MOORE, H. M., October 17th, 1906.
Manager, Austin Gas Light Company, 907 Congress Avenue, Austin, Texas.

MOORE, NORTHROP, October 17th, 1906.
Assistant Secretary, Wyandotte Gas Company, Hursted Building, Kansas City, Kansas.

MORAN, G. M., October 17th, 1906.
Superintendent, Gas Department, Hattiesburg Traction Company, Hattiesburg, Mississippi.

MOREHEAD, JOHN M., October 17th, 1906.
Consulting Engineer, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

*MORGAN, JOHN EYRE, October 17th, 1906; September 25th, 1907.
Engineer, Consumers Gas Company, Reading, Pennsylvania.

MORGANS, WILLIAM H., October 17th, 1906.
Vice-President, Pontiac Light Company, 509 Orchard Lake Avenue, Pontiac, Michigan.

MORRELL, EDWARD E., October 17th, 1906.
Secretary, National Gas & Electric Company, 184 La Salle Street, Chicago, Illinois.

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MORRIS, DANIEL, October 17th, 1906.
Superintendent, The Owego Gas Light Company, Owego, New York.

MORRIS, ROBERT C., JR., October 17th, 1906.
Superintendent, Binghampton Gas Works, 9 Pine Street, Binghampton, New York.

MORRIS, W. C., October 17th, 1906.
Manager, Gas Department, Ashland Light, Power & Street Railway Company, Ashland, Wisconsin.

MORRIS, W. CULLEN, October 17th, 1906.
Engineer of Construction, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

MORRIS, WILLIAM T., October 17th, 1906.
President and Treasurer, Associated Gas & Electric Company, Ithaca, New York.

MORRISON, HENRY K., October 17th, 1906.
Superintendent, Concord Light & Power Company, 90 North Main Street, Concord, New Hampshire.

MORSE, CHARLES W., October 17th, 1906.
President and General Manager, Amesbury Gas Company, 24 Park Street, Haverhill, Massachusetts.

MORTON, ALBERT B., September 25th, 1907.
Manager, Wakefield Municipal Light Plant, Wakefield, Massachusetts.

MORTON, F. N., October 17th, 1906.
Engineer, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

MORTON, H. E., October 17th, 1906.
Assistant Secretary, Boone Gas Company, Boone, Iowa.

MOSES, FRANK D., October 17th, 1906.
Engineer, Creston Gas and Electric Company, 7 North Stockton Street, Trenton, New Jersey.

MULHOLLAND, S. E., October 17th, 1906.
Secretary and Treasurer, Lima Natural & Artificial Gas Companies, Lima, Ohio.

MURDOCK, JAMES W., October 17th, 1906.
Manager, Bethlehem Consolidated Gas Company, Bethlehem, Pennsylvania.

MURDOCK, S. T., October 17th, 1906.
Secretary and General Manager, La Fayette Gas Company, Fourth and Ferry Streets, La Fayette, Indiana.

MURPHY, CHARLES A., October 17th, 1906.
Manager, Ottawa Gas Light & Coke Company, Ottawa, Illinois.

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MURPHY, W. J., October 17th, 1906.
Vice-President and General Manager, Grand Forks (N. D.) Gas & Electric Company, The Minneapolis Tribune, Minneapolis, Minnesota.

MUSIL, LOUIS F., June 19th, 1907.
Assistant Engineer, H. L. Doherty & Company, 60 Wall Street, New York, New York.

MYERS, JOSEPH B., October 17th, 1906.
The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

NAPHTALZ, SAM L., October 17th, 1906.
Engineer Operation and Maintenance, Pacific Gas & Electric Company, 925 Franklin Street, San Francisco, California.

NEELY, JOHN D. S., October 17th, 1906.
General Manager, Lima Gas Light Company, Lima, Ohio.

NEEMES, W. C., October 17th, 1906.
Superintendent, McKeesport Gas Improvement Company, 311 Twenty-sixth Street, McKeesport, Pennsylvania.

NETTLETON, CHARLES H., October 17th ,1906.
President, Derby Gas Company, and New Haven Gas Light Company, Derby, Connecticut.

NEWBERRY, F. E., October 17th, 1906.
Manager, Citizens Gas Company, 280 Dearborn Avenue, Kankakee, Illinois.

NICCUM, J. B., October 17th, 1906.
Superintendent Three Rivers Gas Company, Three Rivers, Michigan.

NORCROSS, J. ARNOLD, October 17th, 1906.
Secretary and Treasurer, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

NORLAND, MANNING A., October 17th, 1906.
Assistant Engineer, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

NORRIS, ROLLIN, October 17th, 1906.
Superintendent of Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

NORTON, WALTER F., October 17th, 1906.
Superintendent, Gas Department, Nashua Light, Heat & Power Company, 70 East Pearl Street, Nashua, New Hampshire.

NUTE, JOSEPH E., October 17th, 1906.
Manager, Fall River Gas Works Company, 60 North Main Street, Fall River, Massachusetts.

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NUTTING, CHARLES H., October 17th, 1906.
Superintendent, Chicopee Gas Light Company, 37 Gaylor Street, Chicopee, Massachusetts.

OLD, GEORGE, October 17th, 1906.
Agent and Superintendent, St. Augustine Gas & Electric Light Company, St. Augustine, Florida.

OLDS, HOWARD L., October 17th, 1906.
Manager, Commercial Securities Company, 506 Penobscot Building, Detroit, Michigan.

OLMSTED, GEORGE G., October 17th, 1906.
Vice-President, Knoxville (Tenn.) Gas Company, 140 Dearborn Street, Chicago, Illinois.

O'MALLEY, P., October 17th, 1906.
Superintendent of Works, Western United Gas & Electric Company, 95 Prairie Street, Aurora, Illinois.

OSBORN, H. H., October 17th, 1906.
Vice-President and Manager, Ottawa Gas Light & Coke Company, Ottawa, Illinois.

OSBOURNE, E. M., October 17th, 1906.
Manager, Holland City Gas Company, Holland, Michigan.

OSTHOFF, OTTO E., October 17th, 1906.
Vice-President and Chief Engineer, H. M. Byllesby & Company, American Trust Building, Chicago, Illinois.

PAGE, CARTER H., JR., October 17th, 1906.
Commercial Agent, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

PALMER, E. H., October 17th, 1906.
President, Auburn Gas Company, Seneca Falls & Waterloo Gas Light Company, Geneva, New York.

PALMER, H. C., October 17th, 1906.
Engineer, Buffalo Gas Company, 186 Main Street, Buffalo, New York.

PALMER, LOUIS T., October 17th, 1906.
President and General Manager, Niagara Light, Heat & Power Company, Tonawanda, New York.

PARKER, FRANK H., October 17th, 1906.
Manager, Burlington Light & Power Company, 102 South Winooski Avenue, Burlington, Vermont.

PARKER, JOSEPH SMITH, October 17th, 1906.
Superintendent, Frankfort District, United Gas Improvement Company, 4427 Frankford Avenue, Philadelphia, Pennsylvania.

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PARKER, RICHARD MARSH, October 17th, 1906.
Assistant Secretary, Buffalo Gas Company, 186 Main Street, Buffalo, New York.

PARSONS, WILLIAM P., October 17th, 1906.
Engineer of Operation, United Coke & Gas Company, 17 Battery Place, New York, New York.

PATTEN, J. A., October 17th, 1906.
Manager, Holland City Gas Company, Holland City, Michigan.

PATTERSON, HAROLD VINCENT, October 17th, 1906.
Superintendent Gas Department, Tri-City Railway & Light Companies, 127 West Third Street, Davenport, Iowa.

PAYNE, A. I., October 17th, 1906.
Engineer and Manager, Calgary Gas Company, Ltd., 207 Eighth Avenue, Calgary, Alberta, Canada.

PEARSON, W. H., October 17th, 1906.
General Manager and Secretary, Consumers' Gas Company, 19 Toronto Street, Toronto, Ontario, Canada.

PEARSON, W. H., JR., October 17th, 1906.
Engineer, Consumers' Gas Company, 4 Lamport Avenue, Toronto, Ontario, Canada.

PELTON, BERT F., October 17th, 1906.
Superintendent Gas Distribution, St. Paul Gas Light Company, St. Paul, Minnesota.

PELTON, FRANK K., October 17th, 1906.
Secretary, National Gas, Electric Light & Power Company, 402 Union Trust Building, Detroit, Michigan.

PERKINS, BENJAMIN W., October 17th, 1906.
Manager, Altoona Gas Company, 1309 Eleventh Avenue, Altoona, Pennsylvania.

PERKINS, JAY HUGH, October 17th, 1906.
Manager, Wilkesbarre Gas & Electric Company, 27 North Main Street, Wilkesbarre, Pennsyylvania.

PERRY, JOSEPH A., October 17th, 1906.
Assistant to the Engineer of Construction, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

PERSONS, FRED R., October 17th, 1906.
Representative, Maryland Meter Company of Baltimore, 1503 Adams Street, Toledo, Ohio.

PETTES, W. H., October 17th, 1906.
General Auditor, Gas Department, Public Service Corporation of New Jersey, P. O. Box 590, Newark, New Jersey.

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PEW, JOHN N., October 17th, 1906.
Vice-President, Peoples Natural Gas Company, 323 Fourth Avenue, Pittsburg, Pennsylvania.

PLANCK, J. W., October 17th, 1906.
General Manager, Choctaw Gas Light, Heat & Power Company, Box 608, South McAlester, Oklahoma.

PLUMMER, H. W., October 17th, 1906.
Secretary and General Manager, Asheville Electric Company, Asheville, North Carolina.

POLK, ROGER W., October 17th, 1906.
Engineer, Laclede Christy Clay Products Company, Manchester and Sulphur Avenues, St. Louis, Missouri.

POLLITT, L. IRVING, October 17th, 1906.
Erie Electric Motor Company, 1529 Eutaw Place, Baltimore, Maryland.

POND, E. C., October 17th, 1906.
Manager, Petersburg Gas Company, 35 Sycamore Street, Petersburg, Virginia.

PORTER, JOSEPH F., October 17th, 1906.
President, Tri-City Railway & Light Company, Davenport, Iowa.

POTTER, CHARLES F., October 17th, 1906.
Chief Clerk, Dallas Gas Company, 421 Main Street, Dallas, Texas.

POTTER, H. H., October 17th, 1906.
Superintendent, Vincennes Light & Power Company, Vincennes, Indiana.

POWELL, WILLIAM R., October 17th, 1906.
Acting Manager, Artificial Branch, Columbus Gas & Fuel Company, Columbus, Ohio.

POWER, JOHN J., October 17th, 1906.
Superintendent, Cumberland Gas Light Company, Cumberland, Maryland.

PRATT, EDWARD G., October 17th, 1906.
President, Boone (Iowa) Gas Company, 613 New York Life Building, Chicago, Illinois.

PRICE, F. LESTER, October 17th, 1906.
Manager, North Shore Gas Company, Highland Park, Illinois.

PRICHARD, CHARLES F., October 17th, 1906.
General Manager, Lynn Gas & Electric Company, 90 Exchange Street, Lynn, Massachusetts.

PRINTZ, CHARLES H., October 17th, 1906.
Sales Manager, Western Gas Construction Company, Fort Wayne, Indiana.

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FULLEN, JAMES T., October 17th, 1906.
Superintendent, Jackson Gas Company, Jackson, Mississippi.

PURCELL, THEO. V., October 17th, 1906.
157 Michigan Avenue, Chicago, Illinois.

PUTNAM, WILLIAM R., October 17th, 1906.
Manager, Red Wing Gas, Light & Power Company, Red Wing, Minnesota.

QUACKENBUSH, CHARLES, October 17th, 1906.
Manager, St. Clair County Gas & Electric Company, 414 Missouri Avenue, East St. Louis, Illinois.

QUINN, A. K., October 17th, 1906.
Treasurer and General Manager, Newport Gas Light Company, Box 305, Newport, Rhode Island.

RAMSBURG, CHARLES J., October 17th, 1906.
Assistant to Engineer, United Gas Improvement Company, Twenty-second and Filbert Streets, Philadelphia, Pennsylvania.

RAMSDELL, GEORGE G., October 17th, 1906.
President, Ramsdell Inverted Gas Lamp Company, 1123 Broadway, New York, New York.

RAMSEY, WILLIAM HEINES CRAWFORD, October 17th, 1906.
Superintendent, Consumers' Gas Company, 420 Main Street, Johnstown, Pennsylvania.

RANDOLPH, WILLIAM W., October 17th, 1906.
Engineer, Humphreys & Glasgow, 31 Nassau Street, New York, New York.

REDDING, R. M., October 17th, 1906.
Chemist, New Orleans Gas Light Company, Baronne and Common Streets, New Orleans, Louisiana.

REES, RICHARD, October 17th, 1906.
Secretary, Memphis Gas & Electric Company, 12 South Second Street, Memphis, Tennessee.

REGER, W. S., October 17th, 1906.
Superintendent of Meter Department, Laclede Gas Light Company, 2655 Adams Street, St. Louis, Missouri.

REITEMEYER, A. F., October 17th, 1906.
Superintendent, Secretary and Treasurer, Perth Amboy Gas Light Company, 148 Smith Street, Perth Amboy, New Jersey.

RENNIE, W. H., October 17th, 1906.
Managing Director, St. John's Gas Light Company, Water Street, St. Johns, Newfoundland.

REW, IRWIN, October 17th, 1906.
Vice-President, DeKalb County (Ill.) Gas Company, and Sterling (Ill.) Gas & Electric Company, 184 La Salle Street, Chicago, Illinois.

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REYNOLDS, W. E., September 25th, 1907.
Agent Gas and Electric Departments, Public Service Corporation, 109 Montgomery Street, Jersey City, New Jersey.

RHOADES, WILLIAM R., October 17th, 1906.
Superintendent, Springfield Gas Light Company, Springfield, Illinois.

RICE, HENRY L., October 17th, 1906.
General Manager, Western United Gas & Electric Company, Aurora, Illinois.

RICHARDS, FRED M., October 17th, 1906.
General Superintendent, Madison Gas & Electric Company, 126 East Main Stret, Madison, Wisconsin.

RICHARDS, J. L., September 25th, 1907.
President and General Manager, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

RICHARDS, W. A., October 17th, 1906.
Mechanical and Gas Engineer, 216 North Carroll Street, Madison, Wisconsin.

RICHARDS, WILLIAM A., October 17th, 1906.
Manager, Standard Gas Company, of New Jersey, Keyport, New Jersey.

RICHARDSON, FRANK S., October 17th, 1906.
Vice-President, Treasurer and General Manager, North Adams Gas Light Company, 23 Bank Street, North Adams, Massachusetts.

RICHARDSON, WALTER W., October 17th, 1906.
Manager, Buffalo Natural Gas & Fuel Company, 58 Coal & Iron Exchange, Buffalo, New York.

RICHTER, ARTHUR W., October 17th, 1906.
Professor of Experimental Enginering, University of Wisconsin, 929 University Avenue, Madison, Wisconsin.

RISELAY, WILLIAM S., October 17th, 1906.
Secretary and Treasurer, Buffalo Gas Company and Peoples' Gas Light & Coke Company, 186 Main Street, Buffalo, New York.

RITSON, J. M., October 17th, 1906.
Superintendent Sales Department, Birmingham Railway, Light & Power Company, Birmingham, Alabama.

RITTER, CHARLES S., October 17th, 1906.
Secretary, Detroit City Gas Company, 230 Woodward Avenue, Detroit, Michigan.

ROBB, J. M., October 17th, 1906.
General Manager, Chattanooga Gas Company, 619 Cherry Street, Chattanooga, Tennessee.

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ROBERTS, E. C., September 25th, 1907.
General Agent, Public Service Corporation, 114 Main Street, Hackensack, New Jersey.

ROBERTS, F. M., October 17th, 1906.
Superintendent, Westchester Lighting Company, First Avenue, corner First Street, Mount Vernon, New York.

ROBERTS, GEORGE J., October 17th, 1906.
First Vice-President, Public Service Corporation, 575 Broad Street, Newark, New Jersey.

ROBISON, CHARLES D., October 17th, 1906.
Manager, Nyack Gas Light & Fuel Company, Nyack, New York.

ROCHAT, HENRY, October 17th, 1906.
Superintendent of Manufacture, Indianapolis Gas Company, Indianapolis, Indiana.

ROESER, CHARLES J., September 25th, 1907.
Superintendent, Hoboken Gas Works, Public Service Corporation, Hoboken, New Jersey.

ROGERS, W. H., October 17th, 1906.
General Agent, Gas & Electric Departments, Public Service Corporation of New Jersey, 188 Ellison Street, Paterson, New Jersey.

ROOHAN, PATRICK, October 17th, 1906.
Manager, Saratoga Gas, Electric Light & Power Company, 491 Broadway, Saratoga Springs, New York.

ROPER, GEORGE D., October 17th, 1906.
Vice-President, Boone (Iowa) Gas Company, Rockford, Illinois.

ROSENQUEST, EUGENE H., October 17th, 1906.
President and General Manager, Bronx Gas & Electric Company, Main and Second Streets, Westchester, New York.

ROSENTHAL, ALBERT, October 17th, 1906.
123 South Eighth Avenue, Mount Vernon, New York.

ROSS, J. CHARLES, October 17th, 1906.
General Manager, Utah Gas & Coke Company, Salt Lake City, Utah.

ROSSMAN, G. M., October 17th, 1906.
Treasurer, Keene Gas & Electric Company, 18 Roxbury Street, Keene, New Hampshire.

ROWLAND, CHARLES L., October 17th, 1906.
Consulting Engineer, Queens Borough Gas & Electric Company, 114 Green Street, Brooklyn, New York.

ROWLAND, WILLIAM L., October 17th, 1906.
Chemical Engineer, 2815 Gray's Ferry Road, Philadelphia, Pennsylvania.

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ROYCE, FREDERICK P., October 17th, 1906.
Vice-President, Malden & Melrose Gas Light Company, 84 State Street, Boston, Massachusetts.

RUEGENBERG, John M., January 3rd, 1907.
Assistant to Superintendent of Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

RUNNER, R. K., October 17th, 1906.
Manager DeKalb County Gas Company, DeKalb, Illinois.

RUNNER, Z. T. F., October 17th, 1906.
Secretary and Manager, Freeport Gas Light & Coke Company, Freeport, Illinois.

RUSBY, JOHN M., October 17th, 1906.
Engineer of Tests, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

RUSSELL, DANIEL R., October 17th, 1906.
Vice-President, Parker, Russell Mining & Manufacturing Company, 417 Pine Street, St. Louis, Missouri.

RUSSELL, HERMAN, September 25th, 1907.
Superintendent of Gas Manufacturing Department, Rochester Railway & Light Company, Rochester, New York.

RUTTER, THOMAS V., October 17th, 1906.
Rutter & Turner, 32 Spruce Street, New York, New York.

SALTER, W. JAMES, October 17th, 1906.
Superintendent Gas Department, Meridian Light & Railway Company, 917 Twenty-seventh Avenue, Meridian, Mississippi.

SARGENT, FRED H., October 17th, 1906.
Assistant Agent, Lawrence Gas Company, 370 Essex Street, Lawrence, Massachusetts.

SAUNDERS, HARVEY, October 17th, 1906.
Superintendent, Mansfield Gas Company, Mansfield, Arkansas.

SAWYER, F. H., October 17th, 1906.
Secretary and Assistant Manager, City Gas Company, Norfolk, Virginia.

SCHAAF, E. W., October 17th, 1906.
General Foreman, Appliance and Meter Departments, Denver Gas & Electric Company, 407 Seventeenth Street, Denver, Colorado.

SCHADDELEE, RICHARD, October 17th, 1906.
General Manager, Child, Hulswit & Company, Properties, 411 Michigan Trust Building, Grand Rapids, Michigan.

SCHENCK, RUDOLPH, October 17th, 1906.
Assistant Engineer, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

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SCHERCK, LEON H., October 17th, 1906.
Superintendent of Lighting, Birmingham Railway, Light & Power Company, Birmingham, Alabama.

SCHMIDT, EMIL G., October 17th, 1906.
Vice-President and General Manager, Springfield Gas Light Company, Springfield, Illinois.

SCHMIDT, F. W., October 17th, 1906.
General Agent, Hudson Division, Public Service Corporation of New Jersey, 109 Montgomery Street, Jersey City, New Jersey.

SCHNIEWIND, F., October 17th, 1906.
Vice-President, United Coke & Gas Company, 17 Battery Place, New York, New York.

SCHUTT, HARRY S., October 17th, 1906.
General Manager, Michigan City Gas and Electric Company, Michigan City, Indiana.

SCHWARN, C. A., October 17th, 1906.
General Superintendent, National Gas, Electric Light & Power Company, 402 Union Trust Building, Detroit, Michigan.

SCOBELL, E. C., October 1st, 1907.
Assistant Auditor, Rochester Railway & Light Company, Rochester, New York.

SCRANTON, GEORGE H., October 17th, 1906.
Secretary, Derby Gas Company, 22 Elizabeth Street, Derby, Connecticut.

SCRANTON, WORTHINGTON, October 17th, 1906.
Vice-President, Hyde Park Gas Company, 115 Wyoming Avenue, Scranton, Pennsylvania.

SEAMON, J. FRED, October 17th, 1906.
Constructing Engineer, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

SEARLE, ROBERT M., October 17th, 1906.
General Manager, Rochester Railway & Light Company, 34 Clinton Avenue North, Rochester, New York.

SEARS, CLIFTON W., October 17th, 1906.
General Contracting Agent, Kansas Natural Gas Company, Chanute, Kansas.

SECORD, WARREN L., October 17th, 1906.
Superintendent, Northern Westchester Lighting Company, Engineer Gas Department, Peekskill Lighting & Railway Company, 127 Main Street, Ossining, New York.

SELIG, A. L., September 25th, 1907.
General Manager, Gas and Electric Departments, The Edison Electric Company, Los Angeles, California.

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SERRILL, WILLIAM J., October 17th, 1906.
Engineer of Distribution, Philadelphia Gas Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

SEXTON, H. W., October 17th, 1906.
General Manager, Anniston Electric & Gas Company, Anniston, Alabama.

SEYMOUR, WILLIAM W., October 17th, 1906.
President, Gray's Harbor Gas Company of Aberdeen, Washington, 401 Provident Building, Tacoma, Washington.

SHACKLETTE, R., October 17th, 1906.
Manager, Adrian Gas Company, 860 Greenwood Avenue, Detroit, Michigan.

SHAFFNER, SAMUEL, C., January 3rd, 1907.
Gas Engineer, 613 New York Life Building, Chicago, Illinois.

SHARP, LEWIS B., October 17th, 1906.
General Superintendent, Queens Borough Gas & Electric Company, Far Rockaway, New York.

SHATTUCK, A. F., October 17th, 1906.
Chief Chemist, The Solvay Process Company, Detroit, Michigan.

SHATTUCK, JOHN D., October 17th, 1906.
General Manager, Suburban Gas Company, Sixth and Welsh Streets, Chester, Pennsylvania.

SHAW, H. S., October 17th, 1906.
Treasurer and Superintendent, Webster Electric Company, Webster, Massachusetts.

SHELTON, FREDERICK H., October 17th, 1906.
Secretary of Various Gas Companies, 1004 Pennsylvania Building, Philadelphia, Pennsylvania.

SHEPARD, FREDERICK C., October 17th, 1906.
Superintendent, Minneapolis Gas Light Company, 16 Seventh Street, Minneapolis, Minnesota.

SHERMAN, F. C., October 17th, 1906.
Consulting Engineer, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

SHERWOOD, E. J., October 17th, 1906.
Assistant Superintendent Meter Department, Laclede Gas Light Company, 2655 Adams Street, St. Louis, Missouri.

SHERWOOD, M. S., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 226 Springfield Avenue, Summit, New Jersey.

SIMONS, KEATING LEWIS, September 25th, 1907.
Superintendent Gas Department, Birmingham Railway, Light & Power Company, Birmingham, Alabama.

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SIMPSON, COLIN C., October 17th, 1906.
Assistant Secretary and General Superintendent of Mains, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

SIMPSON H., October 17th, 1906.
Assistant Foreman of Works, City Gas Company, Norfolk, Virginia.

SIMPSON, MASTIN, October 17th, 1906.
Secretary and Treasurer, H. P. Wright Investment Company, 730 Delaware Street, Kansas City, Missouri.

SINSEL, OTIS A., October 17th, 1906.
Superintendent Station B, Detroit Gas Company, 155 Melbourne Avenue, Detroit, Michigan.

SKELLENGER, DANIEL PERRY, January 3rd, 1907.
General Manager, Morristown Gas Light Company, 43 South Street, Morristown, New Jersey.

SKINNER, SAMUEL, October 17th, 1906.
Superintendent, Montreal Light, Heat & Power Company, 177 Harbour Street, Montreal, Quebec, Canada.

SLADE, RICHMOND E., October 17th, 1906.
Treasurer and General Manager, Hartford City Gas Light Company, 565 Main Street, Hartford, Connecticut.

SLATER, ALPHEUS B., October 17th, 1906.
General Manager, Societe Anonyme de Gaz, Rio de Janeiro, Brazil, South America.

SLOAN, J. C., October 17th, 1906.
Manager, Port Huron Gas Company, Port Huron, Michigan.

SMALL, J. C., October 17th, 1906.
Secretary and Treasurer, Aurora Gas Light, Coal & Coke Company, Aurora, Indiana.

SMART, F. R., JR., October 17th, 1906.
General Manager, York Gas Company, York, Pennsylvania.

SMART, GEORGE M., October 17th, 1906.
Secretary, Dayton Gas Light & Coke Company, Dayton, Ohio.

SMITH, A. J., October 17th, 1906.
Superintendent, St. Albans Gas Light Company, 29 Kingman Street, St. Albans, Vermont.

SMITH, ELMER W., January 3rd, 1907.
Manager, Kewaunee Light & Power Company, Kewaunee, Illinois.

SMITH, JOHN W., October 17th, 1906.
Superintendent, Northern Liberties Gas Company, United Gas Improvement Company, Agent, 60 Laurel Street, Philadelphia, Pennsylvania.

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SMITH, WILLIAM HENRY, October 17th, 1906.
Superintendent of Distribution, United Gas Improvement Company, 1931 South Ninth Street, Philadelphia, Pennsylvania.

SNOW, WILLIAM H., October 17th, 1906.
Manager, City of Holyoke Gas & Electric Department, Holyoke, Massachusetts.

SNYDER, CHARLES S., January 3rd, 1907.
Superintendent, Germantown District, United Gas Improvement Company, 6554 Germantown Avenue, Philadelphia, Pennsylvania.

SOMBART, W. E., October 17th, 1906.
Secretary and Treasurer, Sombart Gas Company, Booneville, Missouri.

SOPER, W. H., October 17th, 1906.
Superintendent, Halifax Electric Tramway Company, 2 Gas Lane, Halifax, Nova Scotia, Canada.

SPANGENBERG, BREWSTER H., October 17th, 1906.
General Manager and Engineer, Rotary Meter Company, 280 Broadway, New York, New York.

SPEAR, M. H., October 17th, 1906.
Manager, New York & Queens Gas Company, 88 Main Street, Flushing, New York.

SPINNING, W. V., October 17th, 1906.
General Superintendent, Logansport and Wabash Valley Gas Company, Peru, Indiana.

SPRAGLE, L. D., October 17th, 1906.
Agent and Superintendent, Fulton County Gas & Electric Company, 18 East Fulton Street, Gloversville, New York.

SPRINGER, EDWARD S., October 17th, 1906.
Manager, Leavenworth Light & Heating Company, 515 Delaware Street, Leavenworth, Kansas.

STACEY, FREDERICK A., October 17th, 1906.
President, Chillicothe Gas & Water Company, Chillicothe, Ohio.

STANNARD, CLARE N., October 17th, 1906.
Secretary, Denver Gas & Electric Company, 415 Seventeenth Street, Denver, Colorado.

STARR, HOWARD W., October 17th, 1906.
Vice-President and Manager, Mohawk Gas Company, Schenectady, New York.

STECK, HENRY, October 17th, 1906.
Manager, American Light & Heat Company, 631 Chestnut Street, Philadelphia, Pennsylvania.

STEENBERGEN, C. L., October 17th, 1906.
General Manager, Paris Gas Light Company, Paris, Kentucky.

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STEINWEDELL, CARL, October 17th, 1906.
Superintendent, The Columbus Gas and Fuel Company, 135 North Front Street, Columbus, Ohio.

STEINWEDELL, GEORGE, October 17th, 1906.
Superintendent Publicity, St. Paul Gas Light Company, Sixth and Jackson Streets, St. Paul, Minnesota.

STEINWEDELL, WILLIAM, October 17th, 1906.
Quincy, Illinois.

STEINWEDELL, W. E., October 17th, 1906.
Consulting Gas Engineer, 715 Citizens Building, Cleveland, Ohio.

STELLING, C. A., October 17th, 1906.
Assistant Superintendent, Public Service Corporation of New Jersey, Columbia Avenue and Passaic Street, Passaic, New Jersey.

STEPHENS, H. H., October 17th, 1906.
Manager and Purchasing Agent, El Reno Gas & Electric Company, El Reno, Oklahoma.

STETSON, GEORGE R., October 17th, 1906.
President and General Manager, New Bedford Gas & Edison Light Company, 125 Middle Street, New Bedford, Massachusetts.

STEWART, SAMUEL B., October 17th, 1906.
Assistant General Contracting & Purchasing Agent, Philadelphia Company, 435 Sixth Avenue, Pittsburg, Pennsylvania.

STILES, HARRY B., October 17th, 1906.
Purchasing Agent, St. Paul Gas Light Company, Sixth and Jackson Street, St. Paul, Minnesota.

STILLSON, HOWARD G., October 17th, 1906.
Superintendent of Distribution, Western United Gas & Electric Company, Aurora, Illinois.

STIRZEL, JACOB W., October 17th, 1906.
Engineer of Construction, Philadelphia Gas Works, United Gas Improvement Company, Twenty-second and Market Streets, Philadelphia, Pennsylvania.

STONE, FREDERICK W., October 17th, 1906.
Manager, The Ashtabula Gas Company, Ashtabula, Ohio.

STRAIN, G. A., October 17th, 1906.
Superintendent, Gas Department, Helena Railway & Light Company, Helena, Montana.

STRECKER, ALEXANDER H., October 17th, 1906.
Engineer, Gas Department, Essex Division, Public Service Corporation of New Jersey, 575 Broad Street, Newark, New Jersey.

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STRICKLER, JAMES P., October 17th, 1906.
Superintendent of City Plant, Columbus, Gas & Fuel Company, 135 North Front Street, Columbus, Ohio.

STROHN, C. B., October 17th, 1906.
District Manger, Elgin District, Western United Gas & Electric Company, Milwaukee and Spring Streets, Elgin, Illinois.

STROHN, R. N., October 17th, 1906.
Treasurer, Western United Gas & Electric Company, Aurora, Illinois.

STROUD, MORRIS W., October 17th, 1906.
President, The American Gas Company, 222 South Third Street, Philadelphia, Pennsylvania.

SUCHOMEL, THOMAS, October 17th, 1906.
Works Foreman, Cedar Rapids Gas Light Company, Cedar Rapids, Iowa.

SUMMERS, GEORGE, October 17th, 1906.
Assistant Engineer, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

SUMMERS, T. W., October 17th, 1906.
Manager, Ithaca Gas Light Company, Cayuga and Green Streets, Ithaca, New York.

SUMMEY, D. L., October 17th, 1906.
Mechanical Engineer, Chase Rolling Mill Company, 3 Irving Street, Waterbury, Connecticut.

SWAN, GEO. J., September 25th, 1907.
Superintendent, Consumers' Light, Heat and Power Company, 214 East First Street, Topeka, Kansas.

SWANN, HARRY R., October 17th, 1906.
Chief Inspector, Louisville Gas Company 1022 Floyd Street, Louisville, Kentucky.

SWEETMAN, M. M., October 17th, 1906.
General Superintendent, Kansas Natural Gas Company, 3410 Baltimore Avenue, Kansas City, Missouri.

SWEETMAN, W. D., October 17th, 1906.
Superintendent, Peoples Gas Light & Coke Company, Division Street and Elston Avenue Station, Chicago, Illinois.

TAIT, FRANK M., October 17th, 1906.
Second Vice-President and General Manager. The Dayton Lighting Company, 124 East Fourth Street, Dayton, Ohio.

TALBOT, FRANK, October 17th, 1906.
Superintendent, Secretary and Treasurer, City of Danville Water and Light Department, Main Street, Danville, Virginia.

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TAUSSIG, J. HAWLEY, October 17th, 1906.
Assistant Engineer of Tests, United Gas Improvement Company Broad and Arch Streets, Philadelphia, Pennsylvania.

TAYLER, GEORGE H., October 17th, 1906.
Secretary and Treasurer, The Warren Gas Light Company, 209 South Main Street, Warren, Ohio.

TAYLOR, JOHN BYRON, September 25th, 1907.
Treasurer, Watertown Gas Light Company, Watertown, New York.

TAYLOR, JOSEPH D., Jr., October 17th, 1906.
Manager, Wausau Gas Company, Wausau, Wisconsin.

TENNEY, ALBERT BALL, October 1st, 1907.
General Manager, Malden Electric Company, Malden and Melrose Gas Light Company, Malden, Massachusetts.

TENNEY, CHARLES H., October 17th, 1906.
President, Springfield Gas Company, Springfield, Massachusetts.

TERRY, H. WARREN, Jr., October 17th, 1906.
Superintendent, Westchester Lighting Company, 119 Woodworth Avenue, Yonkers, New York.

THOMAS, CHARLES G. M., October 17th, 1906.
Vice-President and General Manager, New York & Queens Gas Company, Dallas (Texas) Gas Company, 208 Fifth Avenue, New York, New York.

THOMAS, W. F., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 392 George Street, New Brunswick, New Jersey.

THOMPSON, PAUL, October 17th, 1906.
Assistant to Third Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

THOMSON, GEORGE W., October 17th, 1906.
Manager, New Business Department, Suburban Gas Company, Sixth and Welsh Streets, Chester, Pennsylvania.

THUMAN, FREDERIC, September 25th, 1907.
Chief Engineer and General Manager, Humphreys and Glasgow, 38 Victoria Street, London, S. W., England.

THWING, ORRELL O., October 17th, 1906.
Chief Engineer, Western Gas Construction Company, Fort Wayne, Indiana.

TIPPY, CHARLES W., October 17th, 1906.
General Manager, Williamsport Gas Company, West Fourth Street, Williamsport, Pennsylvania .

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TIPPY, B. O., October 17th, 1906.
Vice-President and General Manager, Grand Rapids Gas Light Company, Grand Rapids, Michigan.

TOBEY, FRANKLIN, JR., October 17th, 1906.
Manager, Kingston Gas & Electric Company, 608 Broadway, Kingston, New York.

TOMPKINS, JOHN P., October 17th, 1906.
Secretary and General Manager, Atlantic City Gas & Water Company, Atlantic City, New Jersey.

TRAVER, A. F., October 17th, 1906.
Engineer, Grand Rapids Gas Light Company, Grand Rapids, Michigan.

TRAVIS, FRANK M., October 17th, 1906.
Secretary, Winsted Gas Company, Treasurer, Torrington Electric Light & Gas Company, 58 Church Street, Torrington, Connecticut.

TRELEAVEN, L. G., September 25th, 1907.
Manager, Consumers' Light, Heat and Power Company, 824 Kansas Avenue, Topeka, Kansas.

TUCKER, C. A., October 17th, 1906.
Assistant Treasurer, Rochester Railway & Light Company, Rochester, New York.

TULL, LUCIEN P. F., October 17th, 1906.
Auditor, New Amsterdam Gas Company, 131 East Twenty-third Street, New York, New York.

TURNEY, HENRY D., October 17th, 1906.
Vice-President and Treasurer, The Columbus Gas & Fuel Company, 135 North Front Street, Columbus, Ohio.

TUTTLE, W. B., October 17th, 1906.
Vice-President and General Manager, San Antonio Gas & Electric Company, San Antonio, Texas.

TUTWILER, CARRINGTON CABELL, October 17th, 1906.
Chemist, The United Gas Improvement Company, 1706 North Broad Street, Philadelphia, Pennsylvania.

UPSON, C. W., October 17th, 1906.
President, Mansfield Gas Light Company, Mansfield, Ohio.

UTLEY, P. L., October 17th, 1906.
General Manager, Watertown Gas & Electric Company, Watertown, Wisconsin.

VAN NESS, L. G., October 17th, 1906.
Assistant Engineer, Laclede Gas Light Company, 22 North Second Street, Memphis, Tennessee.

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VINCENT, G. I., October 17th, 1906.
Engineer, Des Moines Gas Company, 413 Locust Street, Des Moines, Iowa.

VOLLUM, WILLIAM HOBSON, October 17th, 1906.
Superintendent, North Penn Gas Company, Fort Washington, Pennsylvania.

VONMAUR, JACOB D., October 17th, 1906.
Superintendent Street Department, Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

WAINRIGHT, ARTHUR V., October 17th, 1906.
Manager, Mohawk Gas Company, Schenectady, New York.

WAKEMAN, E. A., October 17th, 1906.
General Manager, Citizens' Gas and Fuel Company, Terre Haute, Indiana.

WALKER, M. T., October 17th, 1906.
Manager, Beaumont Gas Light Company, Beaumont, Texas.

WALKER, WILLIAM L., October 17th, 1906.
Superintendent Gas Department, Fitchburg Gas & Electric Light Company, Fitchburg, Massachusetts.

WALLACE, R. A., October 17th, 1906.
Manager, Quebec Gas Company, Quebec, Quebec, Canada.

WALLACE, WILLIAM, October 17th, 1906.
Superintendent, La Fayette Gas Company, La Fayette, Indiana.

WALTERS, BENJ. S., October 17th, 1906.
Manager, South Bend & Mishawaka Gas Company, 215 South Michigan Street, South Bend, Indiana.

WARING, GEORGE H., October 17th, 1906.
Superintendent, Omaha Gas Company, Twentieth Street and Lincoln Avenue, Omaha, Nebraska.

WARMINGTON, DANIEL R., October 17th, 1906.
Vice-President and General Manager, Peoples Gas Light Company, 410 Pearl Street, Cleveland, Ohio.

WARMINGTON, GEORGE H., October 17th, 1906.
President, Peoples' Gas Light Company, 410 Pearl Street, Cleveland, Ohio.

WARNER, GEORGE H., October 17th, 1906.
Secretary and Treasurer, William M. Crane Company, 1131 Broadway, New York, New York.

WARNKING, GEORGE, October 17th, 1906.
Superintendent, Gas Department, Citizens' Railway & Light Company, Muscatine, Iowa.

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WATERS, JOHN A., October 17th, 1906.
Assistant Superintendent, Gas Department, The Stamford Gas & Electric Company, 75 Henry Street, Stamford, Connecticut.

WEHNER, ADOLPH FREDERICK, October 17th, 1906.
Secretary, Isebell-Porter Company, 46 Bridge Street, Newark, New Jersey.

WELCH, WILLIAM MCNAIR, October 17th, 1906.
Chief Engineer, Kansas Natural Gas Company, Independence, Kansas.

WELSH, WILLIAM J., October 17th, 1906.
Superintendent, New York & Richmond Gas Company, 264 Bay Street, Stapleton, New York.

WEST, GEORGE M., October 17th, 1906.
Superintendent, Standard Gas Company, 229 Mill Street, Danville, Pennsylvania.

WEST, WILLIAM D., October 17th, 1906.
General Superintendent, Federal Gas Corporation, 522 First National Bank Building, Chicago, Illinois.

WEST, WILLIAM H., October 17th, 1906.
Secretary and Assistant Treasurer, Altoona Gas Company, Altoona, Pennsylvania.

WESTCOTT, JOHN TOWNSEND, October 17th, 1906.
Consulting Engineer, 19 Abingdon Street, Westminster, S. W., London, England.

WHEELER, FRED P., October 17th, 1906.
Gas Engineer, Semet-Solvay Company, Syracuse, New York.

WHEELER, H. A., September 25th, 1907.
Agent, Gas and Electric Departments, Public Service Corporation, 27 West 8th Street, Bayonne, N. J.

WHIPPLE, HENRY S., October 17th, 1906.
Manager, Rockford Gas Light & Coke Company, 201 Mulberry Street, Rockford, Illinois.

WHITCOMB, H. D., JR., October 17th, 1906.
General Manager Gas Department, Public Service Corporation of New Jersey, 575 Broad Street, Newark, New Jersey.

WHITE, CHARLES E., October 17th, 1906.
Manager, New Business Department The Union Gas and Electric Company, Cincinnati, Ohio.

WHITE, E. C., October 17th, 1906.
Eastern Manager, The Western Gas Construction Company, Room 1909, 25 Broad Street, New York, New York.

WHITE, HENRY H., October 17th, 1906.
Engineer and Manager, Muskogee Ice & Power Company, Box 775, Muskogee, Oklahoma.

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WHITTAKER, ALAN DEAN, October 17th, 1906.
Engineer, Bergen Division Gas Department, Public Service Corporation, 114 Main Street, Hackensack, New Jersey.

WHITTED, T. B., October 17th, 1906.
Machinery Representative, Westinghouse Machine Company, Chemical Building, St. Louis, Missouri.

WHITTIER, CHARLES R., October 17th, 1906.
Engineer, Robins Conveying Belt Company, Park Row Building, New York, New York.

WHITTON, W. H., October 17th, 1906.
Purchasing Agent, Laclede Gas Light Company, 716 Locust Street, St. Louis, Missouri.

WHYSALL, GEORGE, October 17th, 1906.
General Manager, Columbus, Delaware & Marion Railway and Light Company, Delaware, Ohio.

WILKINSON, A. L., October 17th, 1906.
Treasurer, National Gas, Electric Light & Power Company, 402 Union Trust Building, Detroit, Michigan.

WILLARD, FRED A., January 16th, 1907.
Commercial Agent, Rochester Railway & Light Company, Rochester, New York.

WILLIAMS, CHARLES H., October 17th, 1906.
General Manager, Wisconsin Light & Power Company, La-Crosse, Wisconsin.

WILLIAMS, E. H., October 17th, 1906.
Agent and Superintendent, United Gas Improvement Company, Waterbury, Connecticut.

WILLIAMS, GEORGE, October 17th, 1906.
Commercial Specialist, Henry L. Doherty & Company, 60 Wall Street, New York, New York.

WILLIAMS, HERBERT G., October 17th, 1906.
Manager, Peoples Gas Company, Pottstown, Pennsylvania,

WILLIAMS, LUTHER S., October 17th, 1906.
Manager, Harrisburg Gas Company, Harrisburg, Pennsylvania.

WILLIAMS, WILLIAM L., October 17th, 1906.
Engineer, Gas Department, Passaic Division, Public Service Corporation of New Jersey, 63 Twelfth Avenue, Paterson, New Jersey.

WILLIAMSON, JOHN, October 17th 1906.
Consulting Engineer, Peoples Gas Light & Coke Company, 157 Michigan Avenue, Chicago, Illinois.

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WILLSEY, JOSEPH H., October 17th, 1906.
Foreman, Ashtabula Gas Company, 11 Prospect Street, Ashtabula, Ohio.

WILSON, G. J., October 17th, 1906.
Fort Tryon Hall, 196th Street and Fort Washington Avenue, New York, New York.

WILSON, H. H., January 3rd, 1907.
Manager, Fort Madison Gas Light Company, Fort Madison, Iowa.

WILSON, WILLIAM, October 17th, 1906.
Superintendent, Peoples Gas Light & Coke Company, Twenty-second Street and Center Avenue, Chicago, Illinois.

WILSON, W. A., October 17th, 1906.
Manager, Portage American Gas Company, 604 Chestnut Street, Rockford, Illinois.

WISHART, T. P., January 3rd, 1907.
General Superintendent, La Fayette Gas Company, La Fayette, Indiana.

WITHERBY, EDWIN C., October 17th, 1906.
General Superintendent, Semet-Solvay Company, Syracuse, New York.

WITHERBY, EDWIN E., October 17th, 1906.
General Manager, United Gas & Electric Company, 40 Wall Street, New York, New York.

WOLFF, S. E., October 17th, 1906.
General Manager, Saginaw City Gas Company, 134 South Washington Avenue, Saginaw, Michigan.

WONES, W. R., October 17th, 1906.
Manager, Owensboro Gas Light Company, Owensboro, Kentucky.

WOOD, STUART, October 17th, 1906.
Treasurer, Macon (Ga.) Gas Light & Water Company, 400 Chestnut Street, Philadelphia, Pennsylvania.

WOOD, THOMAS B., October 17th, 1906.
Manager, Berlin Gas Company, Berlin, Wisconsin.

WOOD, WILLIAM AUSTIN, October 17th, 1906.
Chief Engineer and Assistant General Manager, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

WOOD, WILLIAM MUSGRAVE, October 1st, 1907.
Superintendent of Distribution, Kansas City, Missouri, Gas Company, Kansas City, Missouri.

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WOODS, GEORGE E., October 17th, 1906.
Engineer of Manufacturing, Consolidated Gas Company of New York, 4 Irving Place, New York, New York.

WOODWARD, RALPH, October 17th, 1906.
Consulting Gas Engineer, 11 Auburn Street, Worcester, Massachusetts.

WOOLLEN, ARTHUR L., October 17th, 1906.
Independent Engineer, 42 Pine Street, New York, New York.

WORTENDYKE, I. F., October 17th, 1906.
Superintendent, New Gas Light Company, 5 North Main Street, Janesville, Wisconsin.

WRIGHT, E. J. H., October 17th, 1906.
Secretary and Manager, Northwestern Gas Light & Coke Company, 115 North Oak Park Avenue, Oak Park, Illinois.

WRIGHT, W. H., October 17th, 1906.
Superintendent, Coke Plant, Zenith Furnace Company, West Duluth, Minesota.

WRIGHT, WM. W., September 25th, 1907.
Superintendent, Morristown Gas Light Company, Morristown, New Jersey.

WRIGHTINGTON, EDGAR N., October 17th, 1906.
Secretary and Manager, Commercial Department, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

WYANT, ROBERT E., October 17th, 1906.
Engineer, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

WYNESS, ALEXANDER, Jr., October 17th, 1906.
Manager, Vincennes Light and Power Company, Vincennes, Indiana.

YORK, GEORGE W., October 17th, 1906.
Secretary and Treasurer, Alliance (Ohio) Gas & Electric Company, Cuyahoga Building, Cleveland, Ohio.

YORKE, EUGENE H., October 17th, 1906.
Engineer and Superintendent, Portland Gas Company, 40 West Commercial Street, Portland, Maine.

YOUNG, ALFRED W., October 17th, 1906.
Superintendent, Knoxville Gas Company, Knoxville, Tennessee.

YOUNG, GILBERT A., October 17th, 1906.
Assistant Professor of Mechanical Engineering, Purdue University, 409 University Avenue, West Lafayette, Indiana.

YOUNG, JOHN, October 17th, 1906.
Consulting Superintendent, Alleghany Heating Company, 435 Sixth Avenue, Allegheny, Pennsylvania.

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YOUNG, JOHN T., January 3rd, 1907.
General Manager, Muskegon Traction & Lighting Company, Muskegon, Michigan.

YOUNG, PETER, October 17th, 1906.
Secretary and Treasurer, Conneaut (Ohio) Gas Light & Fuel Company, 202 Lewis Block, Pittsburg, Pennsylvania.

YOUNG, PERCY S., October 17th, 1906.
Comptroller, Public Service Corporation of New Jersey, 763 Broad Street, Newark, New Jersey.

YOUNG, ROBERT, October 17th, 1906.
General Manager, Consolidated Gas Company, 435 Sixth Avenue, Pittsburg, Pennsylvania.

YOUNG, R. R., October 17th, 1906.
General Agent, Public Service Corporation of New Jersey, Newark, New Jersey.

ZAHM, A. WILFORD, October 17th, 1906.
General Manager, Brice Gas & Electric Company, Mason City, Iowa.

ZEEK, CHARLES F., October 17th, 1906.
Superintendent, Pensacola Gas Company, 25 East Garden Street, Pensacola, Florida.

ZINGG, J. P., September 25th, 1907.
Agent, Gas Department Public Service Corporation, 458 Bloomfield Avenue, Montclair, N. J.

ASSOCIATE MEMBERS.

AIKIN, HUGH CARLON, October 17th, 1906.
Eastern Sales Manager, Eclipse Gas Stove Company, of Rockford, Ill., Eleventh and Madison Streets, Chester, Pennsylvania.

ASENDORF, CARL, October 17th, 1906.
Representative, The Maryland Meter Company, 1307 Railway Exchange, Chicago, Illinois.

ATWATER, C. G., October 17th, 1906.
Engineer, United Coke & Gas Company, 17 Battery Place, New York, New York.

AUE, JOSEPH E., October 17th, 1906.
Mechanical Engineer, Snow Steam Pump Works, Buffalo, New York.

AYERS, C. O., January 3rd, 1907.
Treasurer and General Manager, Chicago Gas Supplies Manufacturing Company, 54 Dearborn Street, Chicago, Illinois.

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AZOY, ANASTASIO C. M., October 17th, 1906.
Manager, Berwind-White Coal Mining Company, 1 Broadway, New York, New York.

BALDWIN, C. KEMBLE, October 17th, 1906.
Chief Engineer, Robins Conveying Belt Company, 1240 Old Colony Building, Chicago, Illinois.

BARBOUR, WILLIAM TEFFT, October 17th, 1906.
President, Detroit Stove Works, 1320 Jefferson Avenue, Detroit, Michigan.

BARGAMIN, CLIFFORD, September 25th, 1907.
General Manager, Novelty Manufacturing Corporation, 327 28th Street, Newport News, Virginia.

BARNES, GEORGE W., October 17th, 1906.
Engineer and Sales Agent, Equitable Meter Company, 112 Graham Street, Pittsburg, Pennsylvania.

BARNES, WILLIAM W., October 17th, 1906.
Manufacturers Selling Agent, Gas Specialties, East Orange, New Jersey.

BEHRINGER, EDWARD A., October 17th, 1906.
Edward E. Behringer Company, 80 Warren Street, New York, New York.

BERRY, F. K., October 17th, 1906.
Sales Manager, American Stove Company, National Stove Company Division, 120 South Fourth Street, St. Louis, Missouri.

BEST, FREDERICK W., October 17th, 1906.
Manufacturer Gas & Electric Fixtures, 52 Franklin Square, Utica, New York.

BIGELOW, LUCIUS SEYMOUR, October 17th, 1906.
President, Light Publishing Company, 265 Broadway, New York, New York.

BINGHAM, R. W., October 17th, 1906.
Contract Agent, Welsbach Street Lighting Company of America, 218 La Salle Street, Chicago, Illinois.

BIRBECK, W. D., October 17th, 1906.
Clerk, Sales Department, Kerr Murray Manufacturing Company, Fort Wayne, Indiana.

BLINKS, WALTER M., October 17th, 1906.
Assistant Manager, General Gas Light Company, Park and Water Streeets, Kalamazoo, Michigan.

BLOCK, BEN. ALTEN, October 17th, 1906.
Public Service Advertising, 71 World Building, New York, New York.

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BOOTH, GEORGE P., October 17th, 1906.
Superintendent, S. R. Dresser Manufacturing Company, Boylston Street, Bradford, Pennsylvania.

BORST, EMIL E., October 17th, 1906.
Engineer, Practical Gas Construction Company, North Chicago, Illinois.

BOWER, J. A., October 17th, 1906.
Secretary and Treasurer, Practical Gas Construction Company, North Chicago, Illinois.

BRILL, ALFRED P., October 17th, 1906.
Assistant to the President, Ruud Manufacturing Company, 340 Second Avenue, Pittsburg, Pennsylvania.

BROWN, D. F., October 17th, 1906.
Manager, Gas Stove Department, Rathbone, Sard & Company, Albany, New York.

BROWNELL, E. E., October 17th, 1906.
Consulting Electrical Engineer, 157 Michigan Avenue, Chicago, Illinois.

BUCKLEY, JOHN C., October 17th, 1906.
Traveling Salesman, George M. Clark & Company, Division American Stove Company, 82 Michigan Avenue, Chicago, Illinois.

BUNNELL, STERLING H., October 17th, 1906.
Works Manager, The Griscom Spencer Company, 90 West Street, New York, New York.

CALLENBACH, J. A., October 17th, 1906.
Chemist, Public Service Corporation of New Jersey, 131 Maple Terrace, Merchantville, New Jersey.

CARPENTER, H. A., October 17th, 1906.
Gas Engineer, with Riter-Conley Manufacturing Company, 56 Water Street, Pittsburg, Pennsylvania.

CARTER, THOMAS B., October 17th, 1906.
Supervisor of City Lighting, 326 City Hall, St. Louis, Missouri.

CARTWRIGHT, HENRY R., October 17th, 1906.
Manager Philadelphia Factory, American Meter Company, Arch and Twenty-second Streets, Philadelphia, Pennsylvania.

CHEESMAN, FRANK P., October 17th, 1906.
Partner, National Paint Company, 100 William Street, New York, New York.

CHISHOLM, CHARLES T., October 17th, 1906.
Traveling Representative, General Gas Light Company, Kalamazoo, Michigan.

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CLAYBOURNE, C. W., October 17th, 1906.
General Manager and Treasurer, Claybourne Burner Company, 1770 Old Colony Building, Chicago, Illinois.

CLIFFORD, THOMAS C., October 17th, 1906.
General Agent, Pittsburg Meter Company, East Pittsburg, Pennsylvania.

COLEMAN, H. W., October 17th, 1906.
Member of Firm of J. K. Dimmick & Company, 2203 Land Title Building, Philadelphia, Pennsylvania.

COMPTON, M. D., October 17th, 1906.
General Superintendent, Hydraulic Motor Service Company, 14 Park Place, New York, New York.

CORBUS, F. G., October 17th, 1906.
Superintendent, Retail Departments, Welsbach Company, United Gas Improvement Company Building, Broad and Arch Streets, Philadelphia, Pennsylvania.

CRANE, WILLIAM M., October 17th, 1906.
President, William M. Crane Company, 1133 Broadway, New York, New York.

CRESSLER, ALFRED M., October 17th, 1906.
Treasurer, Kerr Murray Manufacturing Company, Fort Wayne, Indiana.

CRESSLER, GEORGE H., October 17th, 1906.
Secretary, Kerr Murray Manufacturing Company, Fort Wayne, Indiana.

CRUSE, ARTHUR R., October 17th, 1906.
President, Cruse-Kemper Company, 1205 Stephen Girard Building, Philadelphia, Pennsylvania.

CUNNINGHAM, J. R., October 17th, 1906.
Traveling Salesman, Schneider & Trenkamp Company of Cleveland, Clinton Street, Defiance, Ohio.

DALY, DAVID R., October 17th, 1906.
Vice-President and Treasurer, J. H. Gautier & Company, Green and Essex Streets, Jersey City, New Jersey.

DARLEY, W. S., October 17th, 1906.
Vice-President and Manager, Practical Gas Construction Company, North Chicago, Illinois.

DEAN, MARK, October 17th, 1906.
Sales Manager, Universal Pipe Company, Box 913, New York, New York.

DEANE, EDWARD M., October 17th, 1906.
President, Edward M. Deane & Company, Grand Rapids, Michigan.

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DEGENER, PAUL A., October 17th, 1906.
Secretary and Treasurer, Dempsey Degener Company, Pittsburg, Pennsylvania.

DEHART, J. S., October 17th, 1906.
President, Isbell-Porter Company, 46 Bridge Street, Newark, New Jersey.

DICKEY, EDMUND S., October 17th, 1906.
Treasurer and Manager, The Maryland Meter Company, North and Saratoga Streets, Baltimore, Maryland.

DRESSER, S. R., October 17th, 1906.
President, S. R. Dresser Manufacturing Company, Bradford, Pennsylvania.

DUDLEY, ARTHUR DEAN, October 1st, 1907.
United Gas Improvement Company, Philadelphia, Pennsylvania.

ECKER, HARRISON G., October 17th, 1906.
Salesman, Fairmount Coal Company, 1 Broadway, New York, New York.

ELLIS, A. V., January 3rd, 1907.
Salesman, Schneider and Trenkamp Company, Division American Stove Company, Cleveland, Ohio.

ESAU, RALPH, October 17th, 1906.
Manager of Sales, Barrett Manufacturing Company, 1131 Rebecca Street, Allegheny, Pennsylvania.

FAIRBAIRN, W. P., October 17th, 1906.
District Sales Manager, Humphrey Company, Kalamazoo, Michgan.

FISHER, THOMAS J., October 17th, 1906.
Superintendent Street Lighting, District of Columbia, District Building, Washington, District of Columbia.

FLINN, CHARLES F., October 17th, 1906.
Salesman, Westinghouse Machinery Company, 171 La Salle Street, Chicago, Illinois.

FLOYD, FREDERICK W., October 17th, 1906.
Engineer Gas Works Department, Quintard New York Iron Works Company, 742 East Twelfth Street, New York, New York.

FOWLER, J. S., October 17th, 1906.
Deily & Fowler, 59 Laurel Street, Philadelphia, Pennsylvania.

FRAMPTON, R. C., January 3rd, 1907.
President Pittsburg Water Heater Company, Pittsburg, Pennsylvania.

GAITLEY, JOHN E., October 17th, 1906.
President, Albany Foundry Company, Albany, New York.

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GARRISON, F. L., October 17th, 1906.
President, Kanawha Coal & Coke Company, 702 Mercantile Library Building, Cincinnati, Ohio.

GARRISON, JOHN J., October 17th, 1906.
Treasurer, Stamford Gas Stove Company, Stamford, Connecticut.

GASSETT, A. L., October 17th, 1906.
Secretary, Economy Stove Company, Cleveland, Ohio.

GENAY, THOMAS S., October 17th, 1906.
Chief Clerk to the Third Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

GILDERSLEEVE, DAVID H., October 17th, 1906.
Sales Manager, C. W. Hunt Company, West New Brighton, New York.

GILMAN, GEORGE P., Jr., October 17th, 1906.
Vice President, Lindsay Light Company, 195 Michigan Street, Chicago, Illinois.

GOODMAN, PATRICK, October 17th, 1906.
Manager, Safety Gas Main Stopper Company, 552 East 135th Street, New York, New York.

GRAVES, GEORGE W., October 17th, 1906.
Graves Supply Company, 1 West 34th Street, New York, New York.

GREEN, J. L., October 17th, 1906.
Vice-President, Laclede Christy Clay Products Company, Sulphur and Manchester Avenues, St. Louis, Missouri.

GREGG, FRANK M., October 17th, 1906.
President, Cleveland Street Lighting Company, 89 Second Avenue, Cleveland, Ohio.

GUNDERSON, G. B., September 25th, 1907.
Secretary and Treasurer, Detroit Stove Works, Detroit, Michigan.

HADDEN, JAMES M., October 17th, 1906.
Representative, Green Fuel Economizer Company, 32 Carroll Street, Poughkeepsie, New York.

HAMLINK, L. C., October 17th, 1906.
President and General Manager, Gas Bench Construction Company, Linmar Building, St. Louis, Missouri.

HARPER, H. D., October 17th, 1906.
Manager, American Meter Company, 99 South Jefferson Street, Chicago, Illinois.

HAYWARD, E. BARTLETT, January 3rd, 1907.
Engineer of Construction, Bartlett, Hayward & Company, Scott and Henry Streets, Baltimore, Maryland.

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HAYWARD, STERLING F., October 17th, 1906.
Secretary and Treasurer, Connelly Iron Sponge & Governor Company, 395 Broadway, New York, New York.

HENRY, WILLIAM G., October 17th, 1906.
Vice-President, Detroit Stove Works, 2921 La Salle Street, Chicago, Illinois.

HICKS, GEORGE CLEVELAND, Jr., October 17th, 1906.
Mechanical Engineer, P. H. & F. M. Roots Company, Box 233, Connersville, Indiana.

HIGGINS, C. M., October 17th, 1906.
Representative, The Standard Oil Company, 26 Broadway, New York, New York.

HINMAN, CHARLES W., October 17th, 1906.
President, Hinman Gas Machine Company, 7 Sherman Street, Charlestown District, Boston, Massachusetts.

HOBDELL, GEORGE, October 17th, 1906.
Manager, Phœnix Meter Company, 107 Arch Street, Camden, New Jersey.

HOFFMAN, JULES G., October 17th, 1906.
Jules G. Hoffman Company, 421 Hammond Building, Detroit, Michigan.

HOLMES, A. G., October 17th, 1906.
Secretary and Manager, Pittsburg Meter Company, Box 252 East Pittsburg, Pennsylvania.

HUMPHREY, H. S., October 17th, 1906.
Secretary and General Manager, Humphrey Company, Kalamazoo, Michigan.

HYDE, W. F., October 17th, 1906.
Secretary, Brand Stove Company, Milwaukee, Wisconsin.

INSLEE, CHAS. L., September 25th, 1907.
President, Guarantee Construction Company, 72 Trinity Place, New York City.

ISBELL, CHARLES W., October 17th, 1906.
President, Board of Directors, Isbell-Porter Company, 257 Broadway, New York, New York.

JACOBS, CHARLES H., October 17th, 1906.
Secretary, Treasurer and General Superintendent, Detroit Meter Company, Third and Larned Streets, Detroit, Michigan.

JONES, FRED, October 17th, 1906.
Manager, Barrett Manufacturing Company, Cincinnati, Ohio.

JOHNSTON, E. D., October 17th, 1906.
President and General Manager, P. H. & F. M. Roots Company, Connersville, Indiana.

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KAHN, JULIUS, January 3rd, 1907.
Vice-President, the New York Flexible Metallic Hose and Tubing Company, 173 Lafayette Street, New York, New York.

KAHN, LAZARD, October 17th, 1906.
Vice-President, Estate Stove Company, Hamilton, Ohio.

KANE, WILLIAM, October 17th, 1906.
President and Treasurer, William Kane Manufacturing Company, 1740 Market Street, Philadelphia, Pennsylvania.

KELLUM, BENJAMIN J., October 17th, 1906.
Manager, Western Department, Welsbach Company, 68 Wabash Avenue, Chicago, Illinois.

KENAH, R. L., Jr., October 17th, 1906.
President and Treasurer, Pittsburg Machine Company, New Brighton, Pennsylvania.

KLEIN, B. F., October 17th, 1906.
Gas Fixture & Brass Company, High Avenue and East Fourth Street, Cleveland, Ohio.

KNIGHT, WILLIAM H., October 17th, 1906.
General Manager, Cleveland Gas Meter Company, 2180 East 65th Street, S. E., Cleveland, Ohio.

KOPPERS, HEINRICH, October 1st, 1907.
Engineer and Coke Oven Contractor, Joliet, Illinois.

LAUBER, ALBERT, October 17th, 1906.
Treasurer, Standard Meter and Manufacturing Company, 521 West Forty-fifth Street, New York, New York.

LEAKEY, NATHAN G., October 17th, 1906.
Assistant Secretary, Michigan Ammonia Works, Detroit, Michigan.

LEAMY, ALAN, October 17th, 1906.
Manager, Middle West Department, Welsbach Company, 116 East Chestnut Street, Columbus, Ohio.

LEAVENWORTH, MARK, October 17th, 1906.
Pittsburg Water Heater Company, Box 1109. Pittsburg, Pennsylvania.

LINDSAY, CHARLES R., Jr., October 17th, 1906.
President, Lindsay Light Company, 195 Michigan Stret, Chicago, Illinois.

LITTLE, ARCHIBALD STEVENS BEGG, October 1st, 1907.
Engineer, Missouri Fire Brick Company, St. Louis, Missouri.

LITLE, THOMAS J., JR., October 17th, 1906.
Engineer, Welsbach Company, Gloucester City, New Jersey.

LOCKWOOD, W. A., October 17th, 1906.
General Salesman, Ringen Stove Company, 414 South Sixth Street, St. Louis, Missouri.

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LONG, HERBERT J., October 17th, 1906.
Secretary and Treasurer, Monarch Water Heater Company, 1300 River Avenue, Allegheny, Pennsylvania.

LUQUEER, ROBERT O., October 17th, 1906.
Assistant Engineer, Humphreys & Glasgow, 31 Nassau Street, New York, New York.

LUSH, JOSEPH, October 17th, 1906.
Manager, New York Improved Meter Company, 306 East Forty-seventh Street, New York, New York.

MCCLEARY, ALEXANDER J., October 17th, 1906.
Superintendent, Equitable Illuminating Gas Company, 1109 West Lehigh Avenue, Philadelphia, Pennsylvania.

MCILRAVY, W. N., Octoebr 17th, 1906.
Manager, Barrett Manufacturing Company, 17 Battery Place, New York, New York.

MCNARY, JOHN B., October 17th, 1906.
Manager and Secretary, Canadian Meter Company, Ltd., Hamilton, Ontario, Canada.

MACDONALD, ALBERT, October 17th, 1906.
Superintendent, Metric Metal Works, 801 Sassafras Street, Erie, Pennsylvania.

MANCOURT, EDWARD M., October 17th, 1906.
Western Manager, Fairmont Coal Company, Majestic Building, Detroit, Michigan.

MARQUIS, P. S., October 17th, 1906.
Vice-President, Barrett Manufacturing Comapny, 1100 Fullerton Building, St. Louis, Missouri.

MASON, SIDNEY, October 17th, 1906.
President, Welsbach Company, United Gas Improvement Company Building, Broad and Arch Streets, Philadelphia, Pennsylvania.

MAXWELL, JOSEPH P., October 17th, 1906.
Salesman, C. W. Hunt Company, 904 Park Building, Pittsburg, Pennsylvania.

MAYER, FREDERICK J., October 17th, 1906.
General Manager and Constructing Engineer, Didier-March Company, Keyser Building, Baltimore, Maryland.

MEAD, G. W., October 17th, 1906.
Secretary, Union Carbide Company, 54 Wall Street, New York, New Yor.k

MELCHER, CHARLES W., October 17th, 1906.
Manager, Chicago Branch, Ingersoll-Rand Company, 1510 Old Colony Building, Chicago, Illinois.

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MERKET, G. A., October 17th, 1906.
Engineer, 118 Elm Street, Marlboro, Massachusetts.

MERRILL, E. C., October 17th, 1906.
E. C. Merrill Company, 2915 Smallman Street, Pittsburg, Pennsylvania.

MILLER, FRED A., October 17th, 1906.
General Manager, S. R. Dresser Manufacturing Company, Boyleston Street, Bradford, Pennsylvania.

MOON, O. P., October 17th, 1906.
Manager, Standard Lighting Company, Perkins Avenue, Cleveland, Ohio.

MORAVA, WENSEL, October 17th, 1906.
President, Morava Construction Company, 85th Street and Stewart Avenue, Chicago, Illinois.

MORDUE, THOMAS N., October 17th, 1906.
Coal Merchant, Old Colony Building, Chicago, Illinois.

MORRELL, CLARENCE P., October 17th, 1906.
Sales Agent, Pennsylvania Gas Coal Company, care Buchhol & Morrell, 1 Broadway, New York, New York.

MUELLER, ROBERT, October 17th, 1906.
Secretary, H. Mueller Manufacturing Company, Decatur, Illinois.

MURDOCK, C. BERT, September 25th, 1907.
Gas Engineer, Pine Bluff, Arkansas.

NICHOLS, CARROLL B., October 17th, 1906.
Assistant Secretary, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pennsylvania.

NORTH, F. S., October 1st, 1907.
Treasurer and General Manager, Suffolk Gas & Electric Light Company, Bay Shore, New York.

NORTON, ARTHUR E., October 17th, 1906.
Superintendent, Nathaniel Tufts Meter Company, 455 Commercial Street, Boston, Massachusetts.

NORTON, HARRY A., October 17th, 1906.
Manager, Nathaniel Tufts Meter Co., 455 Commercial Street, Boston, Massachusetts.

NUTTY, G. R., October 17th, 1906.
General Sales Manager, Gulf Refining Company, Frick Building Annex, Pittsburg, Pennsylvania.

OSBORNE, WILLIARD B., October 17th, 1906.
Engineer, Riter-Conley Manufacturing Company, Pittsburg, Pennsylvania.

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OSIUS, GEORGE, October 17th, 1906.
Secretary and Treasurer, Michigan Ammonia Works, Detroit, Michigan.

OWENS, HARRY THURSTON, October 1st, 1907.
Inspector of Lamps and Gas, 13 Park Row, New York, New York.

PALMER, GEORGE Q., October 17th, 1906.
Manager, Quintard Iron Works Company, 742 East Twelfth Street, New York, New York.

PARKER, GEORGE W., October 17th, 1906.
Eastern Agent, Parker Russell Mining and Manufacturing Company, 45 Broadway, New York, New York.

PATTISON, MELVIN, October 17th, 1906.
General Manager of Sales, Brown Hoisting Machine Company, Cleveland, Ohio.

PAYNE, F. H., October 17th, 1906.
Manager, Metric Metal Works, Erie, Pennsylvania.

PEARSON, JOSHUA ASH, October 17th, 1906.
Purchasing Agent, Public Service Corporation of New Jersey, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

PERRY, A. T., October 17th, 1906.
Manager, Barrett Manufacturing Company, 1213 Williamson Building, Euclid Avenue, Cleveland, Ohio.

PHILLIPS, L. R., January 3rd, 1907.
Sales Department, National Tube Company, 1142 Rookery Building, Chicago, Illinois.

PILZ, C., January 3rd, 1907.
Secretary, New York Lead Wool Company, 93 Nassau Street, New York, New York.

PISER, THEO. H., October 17th, 1906.
Manager, Welsbach Company, New England Department, 24 Summer Street, Boston, Massachusetts.

PLANTINGA, PIERRE, October 17th, 1906.
President, The Gas Machinery Company, 719 Citizens Building, Cleveland, Ohio.

PORTER, ROLAND G., October 17th, 1906.
Chemist Engineer, Riter-Conley Manufacturing Company, Pittsburg, Pennsylvania.

POTTER, THEODORE J., October 17th, 1906.
New England Representative, William M. Crane Company, 135 Corey Street, West Roxbury, Massachusetts.

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PRATT, HENRY, October 17th, 1906.
President, Henry Pratt Boiler & Machine Company, 875 South Halsted Street, Chicago, Illinois.

PRENDERGAST, DANIEL J., October 17th, 1906.
General Superintendent, Welsbach Street Lighting Company, of America, 518 West Forty-second Street, New York, New York.

PRICE, W. W., October 17th, 1906.
President, The Dayton Pipe Coupling Company, 435 East First Street, Dayton, Ohio.

RANCKE, LOUIS N., October 17th, 1906.
Vice-President and Manager, Baltimore Retort & Fire Brick Company, Hall & Nicholson Streets, Baltimore, Maryland.

REILLY, JAMES A., October 17th, 1906.
Sales Agent, The Queen City Coal Company, Cincinnati, Ohio.

REEVES, WILLIAM, October 17th, 1906.
President, The Reeves Manufacturing Company, Milford, Connecticut.

REYNOLDS, M. G., October 17th, 1906.
President and General Manager, Reynolds Gas Regulator Company, 1609 Jackson Street, Anderson, Indiana.

RIEHA, EDWARD L., October 17th, 1906.
Gas Engineer, Didier, March Company, Baltimore, Maryland.

ROBERTS, CLARENCE V., October 17th, 1906.
President, Roberts & Mander Stove Company, Eleventh and Washington Avenues, Philadelphia, Pennsylvania.

RODGERS, EDWARD H., October 17th, 1906.
President, Standard Meter Company, Eighth and Mifflin Streets, Philadelphia, Pennsylvania.

ROESCH, DANIEL, October 17th, 1906.
Engineering Department, Westinghouse Machine Company, 443 South Avenue, Wilkinsburg, Pennsylvania.

RUUD, EDWIN, September 25th, 1907.
Manufacturer, Ruud Manufacturing Company, Pittsburg, Pennsylvania.

SALMON, FREDERICK WILLIAM, October 17th, 1906.
Civil and Mechanical Engineer, 127 South Central Avenue, Burlington Avenue, Burlington, Iowa.

SAYER, EUGENE Y., October 17th, 1906.
Vice-President and General Manager, Improved Equipment Company, 60 Wall Street, New York, New York.

SCHALL, HENRY D., October 17th, 1906.
Salesman, Detroit Stove Works, 425 North Grove Avenue, Oak Park, Illinois.

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SCHAUER, FRANK F., October 17th, 1906.
Engineer of Distribution, Syracuse Lighting Company, Syracuse, New York.

SCHEUMANN, THEO. H., October 17th, 1906.
Assistant Engineer, Western Gas Construction Company, Fort Wayne, Indiana.

SCHILLER, CHARLES C., October 17th, 1906.
Traveling Representative, Michigan Stove Company, 1721 Guilford Avenue, Baltimore, Maryland.

SCHURZ, JAMES R., September 25th, 1907.
General Sales Agent, Camden Coke Company, 418 Federal Street, Camden, New Jersey.

SCHUTT, HENRY L., October 17th, 1906.
Traveling Representative, William M. Crane Company, 32 Linden Avenue, Buffalo, New York.

SEEGER, ROBERT, October 17th, 1906.
District Manager, Welsbach Street Lighting Company of America, 712 Roe Building, St. Louis, Missouri.

SHIRRA, J. C., October 17th, 1906.
Western Sales Agent, Standard Lighting Company, Division American Stove Company, 457 Cass Street, Milwaukee, Wisconsin.

SMITH, ARTHUR M., October 17th, 1906.
Treasurer, The Gas Machinery Company, 719 Citizens Building, Cleveland, Ohio.

SNOWDEN, EDWARD P., October 17th, 1906.
President, Parker Gas Producer Company, St. Joseph, Missouri.

SPELLER, FRANK N., January 3rd, 1907.
Engineer, National Tube Company, Frick Building, Pittsburg, Pennsylvania.

STACEY, ANDREW J., October 17th, 1906.
General Sales Agent, The Stacey Manufacturing Company, Station P., Cincinnati, Ohio.

STACEY, JAMES E., October 17th, 1906.
President, The Stacey Manufacturing Company, Station P., Cincinnati, Ohio.

STADELMAN, W. A., October 17th, 1906.
General Sales Manager, The Wellman, Seaver, Morgan Company, 7000 Central Avenue, Cleveland, Ohio.

STEPHENS, W. W., October 17th, 1906.
Manager, Cleveland Department, Welsbach Company, 733 Euclid Avenue, Cleveland, Ohio.

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STEWARD, ROBERT BRUCE, October 17th, 1906.
President, D. M. Steward Manufacturing Company of Canada, Limited, 151 King Street, West, Toronto, Ontario, Canada.

STITES, TOWNSEND, September 25th, 1907.
General Manager, Welsbach Company, Gloucester, New Jersey.

STONE, HERBERT E., October 17th, 1906.
Traveling Engineer, Chapman Valve Manufacturing Company, Indian Orchard, Springfield, Massachusetts.

STONE, THOMAS W., October 17th, 1906.
Assistant Engineer, Western Gas Construction Company, Fort Wayne, Indiana.

STORRS, CHARLES P., October 17th, 1906.
Secretary, Storrs Mica Company, Owego, New York.

STRATTON, S. S., October 17th, 1906.
Chicago Agent, Maryland Meter Company, 1307 Railway Exchange, Chicago, Illinois.

TAPLIN, FRANK E., October 17th, 1906.
General Sales Agent, Youghiogheny & Ohio Coal Company, Western Reserve Building, Cleveland, Ohio.

TAYLOR, H. G., October 17th, 1906.
Asssistant Engineer, Humphreys & Glasgow, 31 Nassau Street, New York, New York.

TERHUNE, CHARLES F., October 17th, 1906.
Vice-President, William M. Crane Company, 1133 Broadway, New York, New York.

THOMAS, RICHARD H., October 17th, 1906.
President, Thomas, Roberts, Stevenson Company, Third and McKean Streets, Philadelphia, Pennsylvania.

THOMAS, RICHARD HENRY, September 25th, 1907.
General Sales Agent, White & Middleton Gas Engine Company, 107 Liberty Street, New York, New York.

TRENKAMP, H. J., October 17th, 1906.
Secretary, American Stove Company, 1787 Fortieth Street, Cleveland, Ohio.

TRIMBLE, R. H., October 17th, 1906.
Engineer, R. D. Wood & Company, 400 Chestnut Street, Philadelphia, Pennsylvania.

UMMACHS, CHARLES E., October 17th, 1906.
Secretary and Treasurer, R. Williamson & Company, 88 West Washington Street, Chicago, Illinois.

VAN WIE, EDWIN G., October 17th, 1906.
Manager, Gas Appliance Department, Detroit Stove Works, 1320 Jefferson Avenue, Detroit, Michigan.

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VOLLUM, CHARLES N., October 17th, 1906.
Certified Public Accountant, Vollum, Fernley & Vollum, 907 Betz Building, Philadelphia, Pennsylvania.

WAGNER, FRED H., January 3rd, 1907.
Chief Engineer, Bartlett, Hayward & Company, Scott & McHenry Streets, Baltimore, Maryland.

WARREN, HENRY J., October 17th, 1906.
President, Stamford Gas Stove Company, Box 388, Stamford, Connecticut.

WEART, SPENCER S., October 17th, 1906.
General Manager and Treasurer, Sun Vapor Street Light Company, 1001 South Market Street, Canton, Ohio.

WEBER, ALBERT J., October 17th, 1906 .
President, Adam Weber Sons, Park Row Building, New York, New York.

WEHNER, ROBERT K., October 17th, 1906.
Treasurer, Isbell-Porter Company, Bridge & Ogden Streets, Newark, New Jersey.

WELCH, JOHN S., October 17th, 1906.
United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

WELLS, FRED K., October 17th, 1906.
President, Fred. K. Wells Company, 265 Broadway, New York, New York.

WESTERMAIER, FRANCIS VICTOR, October 17th, 1906.
Engineer, Welsbach Street Lighting Company of America, N. W. Corner Broad and Arch Streets, Philadelphia, Pennsylvania.

WHARTON, HENRY, October 17th, 1906.
Secretary, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pennsylvania.

WHITAKER, M. C., October 17th, 1906.
General Superintendent, Welsbach Company, Essex & Ellis Streets, Gloucester, New Jersey.

WHITFIELD, ALBERT, October 17th, 1906.
Lindsay Light Company, 195 Michigan Avenue, Chicago, Illinois.

WICKHAM, LEIGH, October 17th, 1906.
Agent, Parker, Russell Mining & Manufacturing Company, Liggett Building, St. Louis, Missouri.

WILE, JULIUS, October 17th, 1906.
President, Wile Power Gas Company, 212 Cutler Building, Rochester, New York.

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WILKIN, JOHN T., October 17th, 1906.
Mechanical Engineer, Connersville Blower Company, 905 Grand Avenue, Connersville, Indiana.

WILSON, EDWARDS F., September 25th, 1907.
Chemist, Irwin, Westmoreland County, Pennsylvania.

WITHERDEN, GEORGE M., October 17th, 1906.
Representative, John J. Griffin & Co., 1513 Race Street, Philadelphia, Pennsylvania.

WOOD, EDWARD R., JR., October 17th, 1906.
Machinery Sales Manager, R. D. Wood & Company, 400 Chestnut Street, Philadelphia, Pennsylvania.

WOOD, GEORGE B., October 17th, 1906.
Engineer, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pennsylvania.

WORTHAM, E. L., October 17th, 1906.
Victoria Hotel, Chicago, Illinois.

YOUNG, L. B., October 17th, 1906.
Manager, Sales Department, Michigan Stove Company, Detroit, Michigan.

ZITZEWITZ, HERMANN, October 17th, 1906.
President, National Machine Works, Sheffield and North Avenues, Chicago, Illinois.

ZWISLER, A. L., October 17th, 1906.
Salesman, General Gas Light Company, Kalamazoo, Michigan.

JUNIOR MEMBERS.

BARNES, H. L., October 17th, 1906.
Manager, Appliance Department, Hartford City Gas Light Company, 11 Central Avenue, East Hartford, Connecticut.

BEEBE, THOMAS RUSSELL, September 25th, 1907.
Manager, Stove & Natural Gas Department, The Peoples Gas Light & Coke Company, 155 Michigan Avenue, Chicago, Illinois.

BOYD, ALBERT M., October 17th, 1906.
Service Foreman, West Philadelphia District, United Gas Improvement Company, 1829 Fountain Street, Philadelphia, Pennsylvania.

BOYER, LYNN H., October 17th, 1906.
Assistant General Foreman, Gas Works, United Gas Improvement Company, 4427 Frankford Avenue, Philadelphia, Pennsylvania.

BURNETT, FREDERICK, October 17th, 1906.
Assistant Chief Engineer, Economical Gas Apparatus Construction Company, 269 Front Street, Toronto, Ontario, Canada.

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BUTLER, JOSEPH F., October 17th, 1906.
Superintendent, Gas Department, Public Service Corporation of New Jersey, New Brunswick, New Jersey.

BUTLER, WILLIAM H., JR., October 17th, 1906.
General Foreman of Services, United Gas Improvement Company, 2111 North Eighteenth Street, Philadelphia, Pennsylvania.

CADWALLADER, L. L., October 17th, 1906.
Superintendent of Distribution, Utah Gas & Coke Company, 35 Twelfth Street, Salt Lake City, Utah.

CALKINS, W. B., October 17th, 1906.
Chemist, Fairmont Coal Company, 605 Mercantile Library Building, Cincinnati, Ohio.

CASSEDY, GEORGE F., October 17th, 1906.
Consolidated Gas Company, 4 Irving Place, New York, New York.

CHRISTY, HENRY B., October 17th, 1906.
General Foreman, United Gas Improvement Company, 1308 Arrott Street, Frankford, Philadelphia, Pennsylvania.

COOMBS, FRED S., October 17th, 1906.
Superintendent, Meter Department, Youngstown Gas & Electric Company, 253 Custer Avenue, Youngstown, Ohio.

CRESSLER, KERR MURRAY, October 17th, 1906.
Assistant Engineer, Kerr Murray Manufacturing Company, Fort Wayne, Indiana.

CUSHMAN, G. H., October 17th, 1906.
Superintendent, Electric Department, San Antonio Gas & Electric Company, 504 Goliad Street, San Antonio, Texas.

DAVIS, J. W., October 17th, 1906.
Superintendent, Meter Department, The Delaware Gas Company, 6 West Winter Street, Delaware, Ohio.

DUNNE, PHILIP, October 17th, 1906.
Superintendent, Gas Department, Queens Borough Gas & Electric Company, Rockaway Park, New York.

EAVENSON, W. K., October 17th, 1906.
Special Inspector of Appliances, Philadelphia Gas Works, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

FISCHER, C. H., October 17th, 1906.
Chemist, Union Gas & Electric Company, 2886 Harrison Avenue, Cincinnati, Ohio.

FITZPATRICK, DAN, October 17th, 1906.
Foreman of Works, St. Augustine Gas & Electric Light Company, St. Augustine, Florida.

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FLOWERS, DEAN WILCOX, October 1st, 1907.
Chemist, Binghamton Gas Works, Binghamton, New York.

FOX, CHARLES J., October 17th, 1906.
Superintendent of Distribution, Suburban Gas Company of Philadelphia, 867 Main Street, Darby, Pennsylvania.

GANNON, JOHN J., October 17th, 1906.
Chief Clerk, Allentown Gas Company, Allentown, Pennsylvania.

GENAY, T. BERTRAM, October 17th, 1906.
Constructing Engineer, United Gas Improvement Company, 1313 Erie Avenue, Philadelphia, Pennsylvania.

GILPIN, FRANCIS HOPKINSON, September 25th, 1907.
Assistant, Department of Tests, United Gas Improvement Company, 260 South Fifteenth Street, Philadelphia, Pennsylvania.

GLEASON, P. D., October 17th, 1906.
Contract Clerk, Denver Gas & Electric Company, 405 Seventeenth Street, Denver, Colorado.

GREEN, ALBERT, October 17th, 1906.
General Foreman of Fitters, The United Gas Improvement Company, 4518 Tacony Street, Philadelphia, Pennsylvania.

GREEN, J. W., October 17th, 1906.
Agent, Westchester Lighting Company, First Avenue, Mount Vernon, New York.

HAMMOND, ERIC W., October 17th, 1906.
Foreman of Fitters, United Gas Improvement Company, 1615 North Ninth Street, Philadelphia, Pennsylvania.

HEMENWAY, W. E., October 17th, 1906.
Superintendent, Warsaw Gas & Electric Company, Warsaw, New York.

INNES, J. A., October 17th, 1906.
Secretary and Treasurer, Citizens Light, Heat & Power Company, 222 North Lucas Avenue, Eagle Grove, Iowa.

JENNINGS, ROBERT JAMES, October 17th, 1906.
General Foreman of Works, Westchester Lighting Company, 342 South Seventh Avenue, Mount Vernon, New York.

JOHNSTON, ERNEST, October 17th, 1906.
Chief Clerk, St. Augustine Gas & Electric Light Company, St. Augustine, Florida.

KEPPELMANN, D. ELLWOOD, October 17th, 1906.
Assistant to District Agent, The Edison Electric Company, 824 State Street, Santa Barbara, California.

KNOTHE, W. J., October 17th, 1906.
Engineer, Improved Equipment Company, 60 Wall Street, New York, New York.

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LEE, C. W., January 3rd, 1907.
Vice-President and Treasurer, C. W. Lee Company, Newark, New Jersey.

LUCENA, JOSEPH, October 17th, 1906.
Chief Clerk, City District, United Gas Improvement Company, 1949 Fitzgerald Street, Philadelphia, Pennsylvania.

MCCAMY, C. C., October 17th, 1906.
Clerk of Works, Atlanta Gas Light Company, Atlanta, Georgia.

MACDOUGALL, HUGH K., October 17th, 1906.
Cadet Engineer and Clerk of Works, Public Service Corporation of New Jersey, 446 Market Street, Newark, New Jersey.

MILLER, MISS ANNA VIRGINIA, October 17th, 1906.
Lecturer and Demonstrator of Scientific Cookery by Gas, 1237 Harrison Street, Kansas City, Missouri.

MILLIGAN, A. F., October 17th, 1906.
Superintendent, Semet Solvay Company, Chester, Pennsylvania.

MOORHOUSE, L. B., October 17th, 1906.
Assistant Superintendent, Gas Department, San Antonio Gas & Electric Company, San Antonio, Texas.

MYERS, EDWARD BRITTAIN, September 25th, 1907.
Assistant Superintendent, City District, Philadelphia Gas Works, Ninth and Dudley Streets, Philadelphia, Pennsylvania.

MYLER, JOHN A., JR., October 17th, 1906.
Engineer, Dallas Gas Company, 204 Peabody Avenue, Dallas, Texas.

NETH, JOHN A., October 17th, 1906.
Foreman, Gas Department, Westchester Lighting Company, 63 Main Street, Tarrytown, New York.

O'CONNELL, CHARLES M., January 16th, 1907.
Assistant Inspector Special Appliances, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

ORDISH, T. BRANDON, October 17th, 1906.
Assistant Chemist, United Gas Improvement Company, Point Breeze, Philadelphia, Pennsylvania.

OTTEN, CHARLES, JR., January 3rd, 1907.
Assistant Superintendent, Westchester Lighting Company, 119 Woodworth Avenue, Yonkers, New York.

PAGE, RAYMOND F., October 17th, 1906.
Care Cleveland Gas Light Company, Cleveland, Ohio.

PERKINS, ROWAN PENROSE, September 25th, 1907.
Foreman of Fitters, United Gas Improvement Company, 2005 De Lancey Street, Philadelphia, Pennsylvania.

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PETURA, FRANK J., October 17th, 1906.
Member of Experimental Corps, Denver Gas & Electric Company, Denver, Colorado.

PICKENS, A. S., October 17th, 1906.
Assistant Superintendent, Waterbury Plant, United Gas Improvement Company, 186 Chestnut Street, Waterbury, Connecticut.

PRATT, EDWARD G., JR., January 3rd, 1907.
Spokane, Washington.

PRICE, WILLIAM H., October 17th, 1906.
Draftsman and Clerk, Providence (R. I.) Gas Company, Lakewood, Rhode Island.

STEVENS, CHARLES H., October 17th, 1906.
Proprietor Memphis Meter Repair Shop, 299 High Street, Memphis, Tennessee.

STEVICK, CRIST H., October 17th, 1906.
Superintendent's Assistant, New Amsterdam Gas Company, Ravenswood, Long Island, New York.

THOMAS, JAMES B., JR., October 17th, 1906.
General Foreman Mains and Services, Chester County Light and Fuel Company, Avondale, Pennsylvania.

THORN, FRED G., JR., October 17th, 1906.
Chief Draftsman, Manufacturing Department, United Gas Improvement Company, 24 North Twenty-second Street, Philadelphia, Pennsylvania.

TINSMAN, E. H., October 17th, 1906.
Chief Clerk, Clearing House, Laclede Gas Light Company, 5639 Vernon Avenue, St. Louis, Missouri.

TOLMAN, WILLIAM NICHOLAS, October 17th, 1906.
Engineer of Construction, United Gas Improvement Company, Twenty-second and Filbert Streets, Philadelphia, Pennsylvania.

WAGNER, EDWIN, October 17th, 1906.
Engineering Department, Henry L. Doherty & Company, 60 Wall Street, New York, New York.

WAY, ALFRED D., JR., October 17th, 1906.
General Main and Service Foreman, West Philadelphia District, United Gas Improvement Company, 3419 Spring Garden, Philadelphia, Pennsylvania.

WEISGERBER, EDWIN C., October 17th, 1906.
Manager and Secretary, Zanesville Gas Light Company, Zanesville, Ohio.

WELLMAN, HOLLEY G., September 25th, 1907.
Manager, Retort Coke Oven Company, Cleveland, Ohio.

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WILLIAMS, THOMAS G., October 17th, 1906.
Assistant Superintendent, Spring Garden District, Philadelphia Gas Works, United Gas Improvement Company, 5643 Ridge Avenue, Philadelphia, Pennsylvania.

WILLIS, CHARLES M., January 3rd, 1907.
Assistant to Consulting Engineer, Alfred E. Forstall, 58 William Street, New York, New York.

WILSON, WARD, October 17th, 1906.
Foreman of Distribution, Easton Gas Light Company, 914 Jackson Street, Easton, Pennsylvania.

ZOOK, SAMUEL KURTZ, October 17th, 1906.
Assistant Superintendent of Distribution, Gas Department, Public Service Corporation, 37 Lombardy Street, Newark, New Jersey.

SUMMARY OF CLASSES OF MEMBERSHIP.

Active Members	930
Associate Members	218
Junior Members	67
	1,215

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MEMBERS OF THE AMERICAN GAS INSTITUTE ARRANGED GEOGRAPHICALLY

Alabama.

Anniston	William Bailey.
	H. W. Sexton.
Birmingham	James A. Emery.
	William B. Miller.
	J. M. Ritson.
	Leon H. Scherck.
	Keating Lewis Simons.
Huntsville	John R. Lynn.
Mobile	Albert F. Kersting.
Montgomery	L. A. Docteur.

Arkansas.

Little Rock	E. Chandler Beach.
Mansfield	Harvey Saunders.
Pine Bluff	B. C. Fowles.
	C. Bert. Murdock.

California.

Bakersfield	James Goodwin.
Jackson	B. E. Letang.
Los Angeles	Ernest William Bell.
	Jos. M. Berkley.
	W. B. Cline.
	William J. Dorr.
	C. W. Koiner.
	Frederick Charles Millard.
	A. L. Selig.
Pasadena	William Bauerhyte.
San Francisco	John A. Britton.
	Edward C. Jones.
	John Martin.
	C. O. G. Miller.
	Sam L. Naphtalz.
Santa Barbara	D. Elwood Keppelmann.
Stockton	Henry Eastland Adams.

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Colorado.

Boulder	F. W. Leland.
Colorado Springs	Ira Abbott Miller.
	R. P. Bache.
Denver	John T. Brady.
	Phillip Cross.
	G. W. Faller.
	R. Garland Gentry.
	P. D. Gleason.
	R. G. Griswold.
	M. E. Malone.
	Frank J. Petura.
	E. W. Schaaf.
	Clare N. Stannard.
Grand Junction	L. W. LeBaron.
Pueblo	Arthur N. Cantril.

Connecticut.

Derby	Charles H. Nettleton.
	George H. Scranton.
East Hartford	H. L. Barnes.
Hartford	Guy K. Dustin.
	Richmond E. Slade.
Meriden	Charles A. Learned.
Milford	William Reeves.
New Haven	J. Arnold Norcross.
	F. C. Sherman.
	Robert E. Wyant.
New London	Alex. J. Campbell.
Rockville	William Morgan Lewis.
Stamford	Ronald Crawford.
	John L. Garrison.
	Walter M. Jackson.
	G. B. Leland.
	Henry J. Warren.
	John A. Waters.
Torrington	Frank M. Travis.
Waterbury	A. S. Pickens.
	D. L. Summey.
	E. H. Williams.
Windsor Locks	Burdette Loomis.
Winsted	Rufus E. Holmes.

Delaware.

Wilmington	W. Frank Bailey.

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District of Columbia.

Washington	C. Clay Bayley.
	Thomas J. Fisher.
	William F. Hart.
	Thomas F. Holden.
	James S. McIlhenny.
	Robert L. Middleton.

Florida.

Gainesville	George I. Doig.
Jacksonville	Clarence S. Hammatt.
	Harry B. Hoyt.
Pensacola	J. C. Dunham.
	Charles F. Zeek.
St. Augustine	Dan Fitzpatrick.
	Ernest Johnston.
	George Old.

Georgia.

Americus	J. H. Hagerty.
Athens	J. H. Maxon.
Atlanta	P. S. Arkwright.
	Edward J. O. Beirne.
	Richard C. Congdon.
	W. L. Cosgrove.
	F. B. Crowell.
	C. C. McCamy.
Brunswick	Albert Fendig.
Columbus	MacDougald Dexter.
Rome	James Ferrier.
Savannah	John J. Conlin.
	John A. Frick.
	John W. Golden.
	Charles L. Lyon.

Illinois.

Aurora	I. C. Copley.
	F. M. James.
	P. O'Malley.
	Henry L. Rice.
	Howard G. Stillson.
	R. N. Strohn.
Belleville	Harry B. Kircher.
Bloomington	William F. Clausen.

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Illinois (Continued)

Chicago .....Knowlton L. Ames.
Carl Asendorf.
C. O. Ayers.
C. Kemble Baldwin.
Thomas R. Beebe.
A. Bement.
R. W. Bingham.
E. E. Brownell.
John C. Buckley.
Alfred A. Chichester.
John C. D. Clark.
C. W. Claybourne.
Mathias Connors.
Edward G. Cowdery.
D. K. Crighton.
Edward S. Davidson.
R. N. Davis.
Fred A. Dawes.
Rufus C. Dawes.
C. L. Day.
Alfred B. Eaton.
H. J. Elliott.
John H. Eustace.
Charles H. Evans.
Albert L. Farr.
Russell S. Feurtado.
Charles F. Flinn.
George P. Gilman, Jr.
Alfred H. Gross.
H. D. Harper.
A. S. Harrington.
William G. Henry.
H. R. Hunt.
J. R. Huntting.
William B. Jackson.
A. H. Johnson.
Benjamin J. Kellum.
Henry I. Lea.
Charles R. Lindsay, Jr.
F. E. Luther.
N. A. McClary.
G. W. McKee.
Joseph Markley.
Charles W. Melcher.
Wensel Morava.

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Illinois (Continued)	
Chicago	John M. Morehead.
	Thomas N. Mordue.
	Edward E. Morrell.
	Manning A. Norland.
	George G. Olmsted.
	Otto E. Osthoff.
	L. R. Phillips.
	Edward G. Pratt.
	Henry Pratt.
	Theo. V. Purcell.
	Irwin Rew.
	Rudolph Schenck.
	Samuel C. Shaffner.
	S. S. Stratton.
	George Summers.
	W. D. Sweetman.
	Charles E. Ummacha.
	William D. West.
	Albert Whitfield.
	John Williamson.
	William Wilson.
	E. L. Wortham.
	Hermann Zitzewitz.
Decatur	John L. Busch.
	Robert Mueller.
DeKalb	R. K. Runner.
Dixon	Henry C. Higgins.
East St. Louis	Charles Quackenbush.
Elgin	Robert F. Fitz.
	C. B. Strohn.
Evanston	R. J. Jenks.
Freeport	Z. T. F. Runner.
Galena	J. B. Howard.
Galesburg	R. A. McLaughlin.
Highland Park	F. Lester Price.
Joliet	William E. Hartman.
	Heinrich Koppers.
Kankakee	F. E. Newberry.
Kewanee	Elmer W. Smith.
La Grange	George H. Dawson.
La Salle	H. E. Chubbuck.
Litchfield	David Davis.
Macomb	F. S. Armstrong.
North Chicago	Emil E. Borst.
	J. A. Bower.
	W. S. Darley.

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Illinois (Continued)

Oak Park	Charles W. Bradley.
	Mathias Britsch.
	Henry D. Schall.
	E. J. H. Wright.
Ottawa	Charles A. Murphy.
	H. H. Osborn.
Peoria	E. W. Eustace.
Princeton	F. C. Duncan.
Quincy	William Steinwedell.
	Harry O. Channon.
Rockford	George D. Roper.
	Henry S. Whipple.
	W. A. Wilson.
Springfield	William R. Rhodes.
	Emil G. Schmidt.
Sterling	Elmer Crawford.
Waukegan	H. T. Crawford.
	George Goodnow.

Indiana.

Anderson	M. G. Reynolds.
Aurora	J. C. Small.
Columbus	C. M. Keller.
Connersville	George C. Hicks, Jr.
	E. D. Johnston.
	John T. Wilkin.
Elwood	E. C. Critchlow.
Fort Wayne	W. D. Birbeck.
	A. D. Cressler.
	Alfred M. Cressler.
	George H. Cressler.
	Kerr Murray Cressler.
	Fred W. Freese.
	Olaf N. Guldin.
	G. Max Hofmann.
	Lothar Hofmann.
	Charles S. Knight.
	Charles H. Printz.
	Theo. H. Scheumann.
	Thomas W. Stone.
	Orrell O. Thwing.
Gary	Leonard Fitzgerald.
Goshen	G. G. Atkinson.
Indianapolis	Philmer Eves.
	Carl H. Graf.
	Charles A. Meeker.
	Henry Rochat.

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Indiana (Continued)

Lafayette	S. T. Murdock.
	William Wallace.
	T. P. Wishart.
Michigan City	G. W. Briggs.
	Harry S. Schutt.
Muncie	J. E. Colvin.
New Albany	James W. Dunbar.
Peru	George M. Dolley.
	W. V. Spinning.
Richmond	Frank K. Lane.
South Bend	Howard Hoffman.
	Benj. S. Walters.
Terre Haute	M. N. Diall.
	E. A. Wakeman.
Vincennes	H. H. Potter.
	Alexander Wyness, Jr.
West Lafayette	Gilbert A. Young.

Iowa.

Boone	H. E. Morton.
Burlington	Edward D. Clary.
	Frederick William Salmon.
Cedar Rapids	A. S. Averill.
	Glenn M. Averill.
	Thomas Suchomel.
Clinton	Thomas Crawford.
Council Bluffs	A. L. English.
Davenport	Frederick W. Kelley.
	Harold V. Patterson.
	Joseph F. Porter.
Des Moines	Jansen Haines.
	G. I. Vincent.
Dubuque	George McLean.
Eagle Grove	J. A. Innes.
Fort Madison	H. H. Wilson.
Iowa City	George S. Carson.
Le Mars	O. H. Hinds.
Mason City	A. Wilfred Zahm.
Muscatine	George Warnking.
Oskaloosa	Campbell W. Fair.
Ottumwa	David S. Milne.
Sioux City	C. C. Gartland.
	Leonard L. Kellogg.
Waterloo	Austin Burt.
	I. C. Elston, Jr.
	R. H. Lawlor.
	J. N. McCallum.

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Kansas.

Chanute	Clifton W. Sears.
Cherryville	John C. Dods.
Emporia	H. Dunlap.
Fort Scott	Freeman Drake Martin.
Independence	William McNair Welch.
Kansas City	George S. Barrows.
	William J. Bertke.
	C. M. Cole.
	W. H. McKenzie.
	Northrop Moore.
Leavenworth	Edward S. Springer.
Topeka	George J. Swan.
	L. G. Treleaven.

Kentucky.

Covington	Stanley A. Foster.
Louisville	A. H. Barrett.
	Frank Huber.
	Donald McDonald.
	Harry R. Swann.
Owensboro	W. R. Wones.
Paducah	Ira C. Covert.
Paris	C. L. Steenbergen.
Richmond	Benj. A. Dougherty.

Louisiana.

New Orleans	W. D. Marshall.
	Thomas David Miller.
	R. M. Redding.

Maine.

Bangor	Vernon K. Gould.
Portland	Eugene F. Yorke.

Maryland.

Baltimore	George Beadenkopf.
	Howard Bruce.
	Charles M. Cohn.
	Charles H. Dickey.
	Edmund S. Dickey.
	E. Bartlett Hayward.
	Thomas J. Hayward.
	Frederick J. Mayer.

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Maryland (Continued)

Baltimore	Alten S. Miller.
	L. Irving Pollitt.
	Louis N. Rancke.
	Edward L. Rieha.
	Charles C. Schiller.
	Fred H. Wagner.
Cumberland	John J. Power.
Frederick	F. O. Enright.
Westminster	John H. Cunningham.

Massachusetts.

Attleboro	William J. Luther.
Boston	Dwight T. Cortis.
	John A. Gould.
	Robert Grant.
	Charles W. Hinman.
	W. E. McKay.
	Arthur E. Norton.
	Harry A. Norton.
	Theo. H. Piser.
	J. L. Richards.
	Frederick P. Royce.
	William Austin Wood.
	Edgar N. Wrightington.
Cambridge	Albert M. Barnes.
Charleston	Samuel J. Fowler.
Chicopee	Charles H. Nutting.
East Boston	N. W. Gifford.
East Cambridge	John P. Kennedy.
Fall River	Charles F. Leonard.
	Joseph E. Nute.
Fitchburg	Henry E. Coggshall.
	William L. Walker.
Gloucester	John A. Coffin.
Haverhill	Charles W. Morse.
Holyoke	William H. Show.
Hyde Park	L. B. Johns.
Lawrence	C. J. R. Humphreys.
	Fred H. Sargent.
Lowell	R. M. Kellogg.
Lynn	Charles F. Prichard.
Malden	Albert B. Tenney.
Marlboro	G. A. Merkt.
New Bedford	Charles H. Gifford.
	Robert Lindsay.
	George R. Stetson.

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Massachusetts (Continued)

Newton	Waldo A. Learned.
North Adams	Frank S. Richardson.
Pittsfield	Harry C. Crafts.
Springfield	Benjamin Bill.
	Dwight F. Burritt.
	Herbert E. Stone.
	Charles H. Tenney.
Wakefield	Albert B. Morton.
Webster	H. S. Shaw.
West Roxbury	T. J. Potter.
Worcester	Charles Dudley Lamson.
	Ralph Woodward.

Michigan.

Ann Arbor	Henry W. Douglas.
Battle Creek	D. N. Frazer.
Charlotte	Edward J. Elles.
Detroit	William Taft Barbour.
	Isaac C. Baxter.
	E. T. Berger.
	Warren S. Blauvelt.
	Irvin Butterworth.
	V. F. Dewey.
	Alex. Dow.
	William H. Frost.
	G. B. Gunderson.
	Jules G. Hoffman.
	Charles H. Jacobs.
	Nathan G. Leakey.
	Alfred G. Lloyd.
	Ernest F. Lloyd.
	James T. Lynn.
	Edward M. Mancourt.
	W. E. Mockett.
	Howard L. Olds.
	George Osius.
	Frank K. Pelton.
	Charles S. Ritter.
	C A. Schwarn.
	R. Shacklette.
	A. F. Shattuck.
	Otis A. Sinsel.
	Edwin G. Van Wie.
	A. L. Wilkinson.
	L. B. Young.

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Michigan (Continued)

Dowagiac	John F. Griffen.
Grand Rapids	Glenn R. Chamberlain.
	Ralph S. Child.
	James Steward Dales, Jr.
	Edward M. Deane.
	John Hellen.
	Frank T. Hulswit.
	Richard Schaddelee.
	B. O. Tippy.
	A. F. Traver.
Hancock	Herbert S. Baer.
	Max H. Cutcheon.
Holland City	E. M. Osbourne.
	J. A. Patten.
Ishpeming	William J. McCorkindale.
Kalamazoo	Walter M. Blinks.
	Frank W. Blowers.
	Charles T. Chisholm.
	W. P. Fairbairn.
	H. S. Humphrey.
	J. J. Knight.
	A. L. Zwisler.
Marshall	Carroll Collins.
Muskegon	Robert R. Choate.
	John T. Young.
Pontiac	William H. Morgans.
Port Huron	J. C. Sloan.
Saginaw	W. H. Barthold.
	S. E. Wolff.
Sault Ste. Marie	John M. Gregory.
Three Rivers	David Elder.
	J. B. Niccum.

Minnesota.

Albert Lea	Ludwig Kemper.
Duluth	C. W. Andrews.
Faribault	B. W. Cowperthwait.
Mankato	Robert E. Brown.
Minneapolis	R. W. Clarke.
	F. W. Little.
	W. J. Murphy
	Frederick C. Shepard.
Red Wing	William R. Putnam.
St. Paul	John P. Crowley.
	Paul Doty.

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Minnesota (Continued)

St. Paul ..... V. L. Elbert.
Henry J. Gille.
Edward J. Gutsche.
Alfred H. Linderoth.
Bert F. Pelten.
George Steinwedell.
H. B. Stiles.
West Duluth.....W. H. Wright.
Winona .....L. C. Graham.

Mississippi.

Hattiesburg .....G. M. Moran.
Jackson .....John Lorenz.
James T. Pullen.
Meridian .....W. James Salter.
Vicksburg..... Samuel E. Linton, Jr.

Missouri.

Booneville .....W. E. Sombart.
Brookefield .....Louis D. Kelsey.
Independence.....Robert S. Miller.
Jefferson City .....P. A. Bertrand.
Kansas City .....Byron E. Chollar.
Ernest A. Cronin.
Harold W. Graeff.
A. Hurlburt.
A. B. Macbeth.
Robert Macmillan.
Miss Anna Virginia Miller.
Mastin Simpson.
M. M. Sweetman.
William M. Wood.
St. Joseph.....Kerr M. Mitchell.
Edward P. Snowden.
St. Louis.....William Alfred Baehr.
F. K. Berry.
Thomas B. Carter.
Joseph Clarke.
Augustin J. Daly.
John Dell.
William S. Dodd.
David G. Fisher.
Samuel A. Forder.
James Green.
J. L. Green.
L. C. Hamlink.

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Missouri (Continued)

St. Louis .....George S. Hessenbruch.
C. L. Holman.
Archibald S. B. Little.
W. A. Lockwood.
Charles A. Magee.
P. S. Marquis.
Roger W. Polk.
W. S. Reger.
Daniel R. Russell.
Robert Seeger.
E. J. Sherwood.
E. H. Tinsman.
Jacob D. Von Maur.
T. B. Whitted.
W. H. Whitton.
Leigh Wickham.
Sedalia .....Wareham S. Baldwin.
Springfield .....W. A. Bixby.

Montana.

Helena .....G. A. Strain.

Nebraska.

Lincoln .....B. C. Adams.
Omaha .....Isaac Battin.
G. W. Clabaugh.
George H. Waring.

New Hampshire.

Concord .....Henry K. Morrison.
Keene .....G. M. Rossman.
Manchester .....Walter G. Africa.
Owen B. Evans.
Nashua..... Walter F. Norton.

New Jersey.

Asbury Park.....Charles W. Bennett.
Atlantic City .....S Bradley.
John P. Tompkins.
Bayonne .....H. A. Wheeler.
Camden .....John J. Burleigh.
George W. Curtiss.
James N. Downey.
Harry Ellis.
Joseph R. Gilkyson.

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New Jersey (Continued)

Camden	George Hobdell.
	F. R. Hutchinson.
	Thomas Littlehales.
	James R. Schurz.
Cape May	O. A. Merchant, Jr.
East Orange	William W. Barnes.
	W. O. Brown.
	John A. Clark.
Elizabeth	Roger Crilley.
	Francis Engel.
Gloucester City	Thomas J. Litle, Jr.
	Townsend Stites.
	M. C. Whittaker.
Hackensack	E. C. Roberts.
	A. D. Whittaker.
Hoboken	John Cabot.
	W. Greacen, Jr.
	Charles J. Roeser.
Jersey City	Joseph B. Ames.
	West Bissell.
	Sterling H. Bunnell.
	Henry R. Cook, Jr.
	David R. Daly.
	E. J. Donahue.
	H. H. Ferris.
	J. P. Hanlon.
	W. E. Reynolds.
	F. W. Schmidt.
Keyport	William A. Richards.
Long Branch	H. C. Abell.
	F. W. Bowen.
	Henry Irwin.
Merchantville	J. A. Callenbach.
Montclair	J. P. Zingg.
Morristown	Robert D. Foote.
	Daniel Perry Skellenger.
	William W. Wright.
Newark	William H. Allen.
	William S. Barker.
	John H. Braine.
	William H. Chadwell.
	Walter L. Chewning.
	P. T. Dashiell.
	J. S. DeHart.
	James P. Dusenberry.

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New Jersey (Continued)

Newark	E. H. Earnshaw.
	C. W. Lee.
	Thomas N. McCarter.
	Hugh MacDougall.
	W. H. Pettes.
	Geo. J. Roberts.
	Alexander H. Strecker.
	Adolph Frederick Wehner.
	Robert K. Wehner.
	H. D. Whitcomb, Jr.
	Percy S. Young.
	R. R. Young.
	Samuel K. Zook.
New Brunswick	Joseph F. Butler.
	W. F. Thomas.
Ocean City	Andrew P. Maloney.
Passaic	J. H. Kilgour.
	C. A. Stelling.
Paterson	Theo. Bunker.
	W. H. Rogers.
	William L. Williams.
Perth Amboy	A. F. Reitemeyer.
Plainfield	W. R. Causbrook.
	Thomas Melick.
Rutherford	Addison Ely.
South Amboy	William E. Bedle.
Summit	M. S. Sherwood.
Trenton	Charles G. Cook.
	Frank D. Moses
Westfield	Harry Denison.
West Hoboken	James Kennedy.

New York.

Albany	D. F. Brown.
	F. S. Dunne.
	John E. Gaitley.
	E. P. Gavit.
	Donald McDonald.
	William McDonald.
Amsterdam	W. H. Cooper.
Bay Shore	F. S. North.
Binghamton	E. E. Eysenbach.
	Dean W. Flowers.
	Robert W. Manier.
	Robert C. Morris, Jr.

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New York (Continued)

Brooklyn	Fred S. Benson.
	Robert Wilder Bush.
	Edward J. Byrne.
	Thomas E. Byrne.
	James H. Jourdan.
	R. M. Lane.
	John D. Logan.
	Charles L. Rowland.
Buffalo	Joseph E. Aue.
	H. C. Palmer.
	Richard Marsh Parker.
	Walter W. Richardson.
	William S. Riselay.
	Henry L. Schutt.
Canandagua	V. A. Miller.
	S. P. Cobb.
Coney Island	J. J. Humphreys, Jr.
Elmira	William W. Cole.
Far Rockaway	Carlton Macy.
	Lewis B. Sharp.
	Oscar H. Fogg.
Flushing	M. H. Spear.
Freeport	William A. Armington.
Geneva	E. H. Palmer.
Gloversville	L. D. Spragle.
Hempstead	S. K. Campbell.
Ithaca	William T. Morris.
	T. W. Summers.
Kingston	Franklin Tobey, Jr.
Little Falls	Henry P. Collins.
Long Island City	C. Cassels Atwood.
	Charles Boone.
	Clifford S. Fox.
	W. F. Lawrence.
	Crist H. Stevick.
Mt. Vernon	William S. Clark.
	J. W. Green.
	Robert James Jennings.
	Alfred M. Keene.
	George T. Macbeth.
	F. M. Roberts.
	Albert Rosenthal.
Newburgh	A. R. Beal.
	William R. Beal.
	B. J. MacDonald.

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New York (Continued)

New York.....H. C. Abell.
Frederick P. Addicks.
Walter R. Addicks.
J. Charles Andrews.
C. G. Atwater.
Anastasio C. M. Azoy.
William E. Barret.
Albert B. Beadle.
Edward A. Behringer.
Lucius S. Bigelow.
Ben Alten Block
A. E. Boardman.
Fred L. Bradley.
William H. Bradley.
James C. Brady.
Ernest C. Brown.
Charles F. Bryant.
Milan R. Bump.
Sterling H. Bunnell.
Herman Burgi.
Elbert P. Callender.
Harold E. Carpenter.
Robert A. Carter.
George F. Cassedy.
Frank P. Cheesman.
B. C. Cobb.
M. D. Compton.
Alfred S. Cooke.
William M. Crane.
Roland A. Davidson.
Mark Dean.
J. Alfred Dixon.
R. M. Dixon.
G. B. Dobbin.
Henry L. Doherty.
Parr H. Dole.
W. M. Eaton.
Harrison G. Ecker.
Arthur H. Elliott.
Geo. B. Evans.
Frederick W. Floyd.
James R. Floyd, Jr.
A. H. Ford.
Alfred E. Forstall.
Frederick W. Frueauff.

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New York (Continued)

New York .....William Gardiner.
Patrick Goodman.
Malcolm M. Graham.
George W. Graves.
A. H. Hall.
Sterling F. Hayward.
C. M. Higgins.
David Leavitt Hough.
William Greely Hoyt.
Alexander C. Humphreys.
Charles L. Inslee.
Charles W. Isbell.
C. N. Jelliffe.
Mervyn E. Johnston.
Edward R. Jourdan.
Julius Kahn.
James S. Kennedy.
W. J. Knothe.
Alanson P. Lathrop.
M. Nisbet Latta.
Albert Lauber.
A. R. Law.
Robert O. Luqueer.
Joseph Lush.
George McDonald.
W. N. McIlravy.
Emerson McMillin.
William D. Marks.
J. H. T. Martin.
J. Alex. Mayers.
G. W. Mead.
William N. Milsted.
Clarence P. Morrell.
W. Cullen Morris.
Louis F. Musil.
Harry T. Owens.
George Q. Palmer.
George W. Parker.
William P. Parsons.
C. Pilz.
Daniel J. Prendergast.
George G. Ramsdell.
William W. Randolph.
Thomas V. Rutter.

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New York (Continued)

New York	Eugene Y. Sayer.
	F. Schniewind.
	Colin C. Simpson.
	Brewster H. Spangenberg.
	H. G. Taylor.
	Charles F. Terhune.
	Charles G. M. Thomas.
	Richard Henry Thomas.
	Lucien P. F. Tull.
	Edwin Wagner.
	George W. Warner.
	Albert J. Weber.
	Fred K. Wells.
	E. C. White.
	Charles R. Whittier.
	George Williams.
	Charles M. Willis.
	G. J. Wilson.
	Edwin E. Witherby.
	George E. Woods.
	Arthur L. Woolen.
Niagara Falls	Albert H. Merritt.
Nyack	Charles D. Robison.
Ossining	W. B. Clements.
	Warren L. Secord.
Oswego	James Dickerson.
Owego	Daniel Morris.
	Charles P. Storrs.
Peekskill	Amos. M. Knapp.
Plattsburgh	George M. Cole.
Poughkeepsie	T. R. Beal.
	James M. Hadden.
Port Chester	Joseph P. Kane.
Rochester	James B. Eaton.
	Joseph P. Haftenkamp.
	Frank Hellen.
	James T. Hutchings.
	Herman Russell.
	E. C. Scobell.
	Robert M. Searle.
	C. A. Tucker.
	Julius Wile.
	Fred A. Willard.
Rockaway Park	Philip Dunne.
Rome	Roy Albright Field.
Saratoga Springs	Patrick Rohan.

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New York (Continued)

Schenectady	George Fullerton.
	John C. Garton.
	Howard L. Starr.
	Arthur V. Wainright.
Stapleton	Thomas O. Horton.
	William J. Welsh.
Syracuse	W. R. Goudy.
	Frank F. Schauer.
	Fred B. Wheeler.
	Edwin C. Witherby.
Tarrytown	John A. Neth.
Tonawanda	Louis T. Palmer.
Utica	Frederick W. Best.
	William J. Cahill.
	Herbert Gilmore Johnson.
	J. Frank Kivlen.
Warsaw	W. E. Hemenway.
Watertown	John B. Taylor.
Waverly	F. A. Gillette.
West Chester	Eugene H. Rosenquest.
West New Brighton	David H. Gildersleeve.
White Plains	Paul Bucher.
Yonkers	Charles Otten, Jr.
	H. Warren Terry, Jr.

North Carolina.

Asheville	H. W. Plummer.
Durham	R. W. Miller.
Greensboro	R. H. Gainwell.
	W. F. Hinton.

Ohio

Akron	A. B. Eilbeck.
Alliance	D. W. Low.
Ashtabula	Frederick W. Stone.
	Joseph H. Willsey.
Canton	Joseph L. Loichot.
	Spencer S. Weart.
Bucyrus	H. O. Dutter.
Chillicothe	Frederick A. Stacey.
Cincinnati	W. B. Calkins.
	A. M. Dolph.
	C. H. Fisher.
	John Franklin.
	F. L. Garrison.
	P. H. Gibbons.

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Ohio (Continued)

Cincinnati	Fred Jones.
	Norman G. Kenan.
	E. E. Miller.
	William A. Miller.
	James A. Reilly.
	Andrew J. Stacey.
	James E. Stacey.
	Charles E. White.
Cleveland	Charles S. Beardslee.
	Martin B. Daly
	A. V. Ellis.
	A. L. Gassett.
	Malcolm S. Greenough.
	Frank M. Gregg.
	Gustavus A. Hyde.
	B. F. Klein.
	William Knight.
	Howard E. Mann.
	Virgil Marani.
	O. P. Moon.
	Raymond F. Page.
	Melvin Pattison.
	A. T. Perry.
	Pierre Plantinga.
	Arthur M. Smith.
	W. A. Stadelman.
	W. E. Steinwedell.
	W. W. Stephens.
	Frank E. Taplin.
	H. J. Trenkamp.
	Daniel Warmington.
	George H. Warmington.
	Holley G. Wellman.
	George W. York.
Columbus	J. W. Garrard.
	Allan Leamy.
	William R. Powell.
	Carl Steinwedell.
	James P. Strickler.
	Henry D. Turney.
Dayton	Henry C. Graves.
	Edward H. Light.
	George Light.
	W. W. Price.

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Ohio (Continued)

Dayton	George M. Smart.
	Frank M. Tait.
Defiance	J. R. Cunningham.
Delaware	J. W. Davis.
	Thomas Clive Jones.
	George Whysall.
Hamilton	Lazard Kahn,
Lima	S. E. Mulholland.
	John D. S. Neeley.
Mansfield	William C. Hedges.
	C. W. Upson.
Middletown	G. N. Clapp.
Newark	Melville Gillett.
Oberlin	A. D. Crow.
	Albert E. Hay.
Portsmouth	B. J. Crahan.
Toledo	C. A. Byers.
	Jos. E. Lockwood.
	Fred R. Persons.
Warren	George Daugherty.
	John C. Gorton.
	George H. Tayler.
Youngstown	Moses Coombs.
	Fred S. Coombs.
Zanesville	Edwin Weisgerber.

Oklahoma.

El Reno	H. H. Stephens.
Guthrie	W. Z. Dibbens.
Muskogee	Henry H. White.
South McAlester	J. W. Planck.

Oregon.

Portland	Walter S. Dole.

Pennsylvania.

Allegheny	Ralph Esau.
	Herbert J. Long.
	John Young.
Allentown	Arthur F. Bigelow.
	William F. Brodnax.
	John J. Gannon.
Altoona	George H. Harper.
	Benjamin W. Perkins.
	William H. West.

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Pennsylvania (Continued)

Ardmore ..... George B. Bains.
Isaac N. Knapp.
Bethlehem ..... James W. **Murdock.**
Bradford ..... George P. Booth.
S. R. Dresser.
Fred A. Miller.
Chester ..... Hugh Carlon Aiken.
A. F. Milligan.
John D. Shattuck.
George W. Thomson.
Danville ..... George M. West.
Darby ..... Charles J. Fox.
Dunbar ..... August F. Hilleke.
Easton ..... B. F. Cresson.
Edwin G. Holzer.
Ward Wilson.
East Pittsburg ..... Thomas C. Clifford.
A. G. Holmes.
Erie ..... Albert MacDonald.
F. H. Payne.
Fort Washington ..... William Hobson **Vollum.**
Greenville ..... A. C. Hartzell.
Hanover ..... R. H. Dutton.
Harrisburg ..... Luther S. Williams.
Irwin ..... Edwards F. Wilson.
Johnstown ..... William H. C. **Ramsey.**
Lebanon ..... W. H. Merritt.
Lewiston ..... Ernest H. Davis.
McKeesport ..... W. C. Neemes.
Milton ..... C. W. Butterworth.
New Brighton ..... R. L. Kenah, Jr.
Norristown ..... Herbert H. Ganser.
Philadelphia ..... H. C. Adams.
Walter A. Allison.
F. M. Arthur.
James Ball.
Henry S. Battin.
Walter W. Beaumont.
Samuel Taylor Bodine.
Charles O. Bond.
Cyrus Borgner.
Albert M. Boyd.
Lynn H. Boyer.
Ernest L. Brundette.
Matthew W. Butler.

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Pennsylvania (Continued)

Philadelphia .....William H. Butler.
Henry R. Cartwright.
William A. Castor.
Henry B. Christy.
Walton Clark.
H. W. Coleman.
David J. Collins.
Roger B. Combs.
F. G. Corbus.
J. A. P. Crisfield.
Arthur R. Cruse.
G. W. Curran.
Samuel P. Curtis.
H. W. Davies.
Carl A. Dickel.
William F. Dorner.
W. F. Douthirt.
Arthur D. Dudley.
W. K. Eavenson.
L. E. Egman.
Walton Forstall.
John Fowler.
J. Scott Fowler.
Walter H. Fulweiler.
William H. Gartley.
T. Bertram Genay.
Thomas S. Genay.
Thomas L. George.
Francis H. Gilpin.
Walter Godley.
Albert Green.
John Gribbel.
Eric W. Hammond.
Charles F. Hardick.
William E. Helme.
Abram C. Howard.
Robert C. James.
William Kane.
John Bartleman Klumpp.
Lewis Lillie.
Joseph Lucena.
Alexander J. McCleary.
John McIlhenny.
John D. McIlhenny.
Andrew P. Maloney.

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Pennsylvania (Continued)

Philadelphia.....William H. Marshall.
Sidney Mason.
Martin Molony.
F. N. Morton.
Edward B. Myers.
Joseph B. Myers.
Carroll B. Nichols.
Rollin Norris.
Charles M. O'Connell.
T. Brandon Ordish.
Carter H. Page, Jr.
Joseph Smith Parker.
Joshua Ashe Pearson.
Rowan P. Perkins.
Joseph A. Perry.
Charles J. Ramsburg.
Clarence V. Roberts.
Edward H. Rodgers.
William L. Rowland.
John M. Rusby.
John M. Ruegenberg.
J. Fred Seamon.
William J. Serrill.
Frederick H. Shelton.
John W. Smith.
William Henry Smith.
Charles S. Snyder.
Henry Steck.
Jacob W. Stirzel.
Morris W. Stroud.
J. Hawley Taussig.
James B. Thomas, Jr.
Richard H. Thomas.
Paul Thompson.
Fred G. Thorn.
William Nichols Tolman.
R. H. Trimble.
Carrington Cabell Tutwiler.
Charles N. Vollum.
Alfred D. Way, Jr.
John S. Welch.
Francis V. Westermaier.
Henry Wharton.
Thomas G. Williams.
George M. Witherden.

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Pennsylvania (Continued)

Philadelphia	Edward R. Wood, Jr.
	George B. Wood.
	Stuart Wood.
Pittsburg	George W. Barnes.
	Alfred P. Brill.
	H. A. Carpenter.
	Paul A. Degener.
	R. C. Frampton.
	Charles L. Gerould.
	Joseph F. Guffey.
	William H. Hammon.
	Miles B. Layton.
	Mark Leavenworth.
	R. S. Lord.
	J. C. McDowell.
	Joseph P. Maxwell.
	E. C. Merrill.
	Carroll Miller.
	G. R. Nutty.
	Willard B. Osborne.
	John N. Pew.
	Roland G. Porter.
	Edwin Ruud.
	Frank N. Speller.
	Samuel B. Stewart.
	Peter Young.
	Robert Young.
Plymouth	William C. Anderson.
Pottstown	Herbert G. Williams.
Pottsville	F. B. Aldrich.
Reading	John H. Keppelman.
	John E. Morgan.
Royersford	John H. Mansur.
Scranton	William McKelvey Marple.
	Worthington Scranton.
Steelton	J. E. Diffenderfer.
Sunbury	George W. Beck.
Tidioute	William Hague.
Westchester	William O. Lamson, Jr.
Wilkesbarre	Hubert D. Gillingham.
	J. Hugh Perkins.
Wilkinsburg	Daniel Roesch.
Williamsport	Charles W. Tippy.
Wyncote	Lewis R. Dutton.
York	F. R. Smart, Jr.

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Rhode Island.

Lakewood	William H. Price.
Newport	A. K. Quinn.
Pawtucket	Frederick W. Easton.
	William McGregor.
Providence	George E. Allyn.
	Edmund Cathels.
	John W. Ellis.

South Dakota.

Aberdeen	Charles A. Howard.
Sioux Falls	Chester N. Chubb.

Tennessee.

Chattanooga	J. M. Robb.
Jackson	H. E. Kincaid.
Knoxville	Alfred W. Young.
Memphis	Richard Rees.
	Charles Stevens.
	L. A. Van Ness.

Texas.

Austin	H. M. Moore.
Beaumont	M. T. Walker.
Dallas	E. B. Meginnis.
	John A. Myler.
	Charles F. Potter.
El Paso	Thomas J. Jones.
Galveston	John Gimper.
Palestine	John H. Fitzgerald.
San Antonio	G. H. Cushman.
	L. B. Moorhouse.
	W. B. Tuttle.

Utah.

Salt Lake City	L. L. Cadwallader.
	John Kempf, Jr.
	J. Charles Ross.

Vermont.

Burlington	Frank H. Parker.
St. Albans	A. J. Smith.

Virginia.

Charlottsville	H. M. Hantzmon.
Danville	Frank Talbot.

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Virginia (Continued)

Fredricksburg	B. F. Bullock.
Newport News	Clifford Bargamin.
Norfolk	Frederick Egner.
	E. C. Hathaway.
	R. J. Marks.
	F. H. Sawyer.
	H. Simpson.
Petersburg	E. C. Pond.
Portsmouth	B. B. Ferguson.
	F. L. Marshall.
Richmond	William P. Knownes.
Staunton	E. M. Funkhouser.

Washington.

Seattle	Charles Russell Collins.
	Frederick K. Lane.
Spokane	E. H. Gimper.
	E. G. Pratt, Jr.
Tacoma	W. A. Aldrich.
	William W. Seymour.

West Virginia.

Shepherdstown	Lawrence Rust Lee.

Wisconsin.

Ashland	W. C. Morris.
Beloit	B. F. Lyons.
Berlin	Thomas B. Wood.
Green Bay	Howard Bixby.
Janesville	I. F. Wortendyke.
Kenosha	Roger N. Kimball.
La Crosse	Charles H. Williams.
Madison	C. F. Burgess.
	John Corscot.
	Fred M. Richards.
	W. A. Richards.
	Arthur W. Richter.
Manitowoc	R. C. Douglas.
	Julius Linstedt.
Milwaukee	John I. Beggs.
	Fred Bredel.
	R. B. Brown.
	R. C. Cornish.
	Sheldon J. Glass.
	O. F. Greim.

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Wisconsin (Continued)

Milwaukee	Ewald Haase.
	Henry M. Humphreys.
	W. F. Hyde.
	R. P. Kraft.
	Bryce McAdam.
	John T. Mason.
	J. C. Shirra.
Oshkosh	Sinclair Mainland.
	William Mainland.
	O. G. F. Markhus.
Portage	W. A. Wilson.
Racine	Henry H. Hyde.
Superior	B. F. Ellison.
Watertown	Charles Mackay.
	P. L. Utley.
Waukesha	H. M. Buck.
Wausau	Joseph D. Taylor, Jr.

Brazil, South America.

Rio de Janeiro	H. B. Harrop.
	Alpheus B. Slater.

Alberta, Canada.

Calgary	A. I. Payne.

British Columbia, Canada.

St. Johns	W. H. Rennie.

Ontario, Canada.

Chatham	P. S. Coate.
Hamilton	William Gibson.
	John D. Keillor.
	John B. McNary.
Toronto	Frederick Burnett.
	L. L. Merrifield.
	W. H. Pearson.
	W. H. Pearson, Jr.
	Robert Bruce Steward.
Ottawa	Charles Forbes.

Quebec, Canada.

Montreal	J. J. Cagney.
	William M. Cathels.
	Samuel Skinner.
Quebec	R. A. Wallace.
Three Rivers	Louis H. Bacque.

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England.

London .....Arthur G. Glasgow.
A. W. Littleton.
Frederic Thuman.
John Townsend Westcott.

Japan.

Tokio.....Suyekuchi Hiramatsu.

Nova Scotia.

Halifax .....W. H. Soper.

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SUMMARY OF GEOGRAPHICAL DISTRIBUTION

Alabama	10	New Jersey	82
Arkansas	4	New York	215
California	17	North Carolina	4
Colorado	15	Ohio	83
Connecticut	24	Oklahoma	4
Delaware	1	Oregon	1
District of Columbia	6	Pennsylvania	189
Florida	8	Rhode Island	7
Georgia	15	South Dakota	2
Illinois	117	Tennessee	6
Indiana	44	Texas	11
Iowa	28	Utah	3
Kansas	13	Vermont	2
Kentucky	9	Virginia	14
Louisiana	3	Washington	6
Maine	2	West Virginia	1
Maryland	17	Wisconsin	36
Massachusetts	47	Brazil	2
Michigan	63	Alberta, Canada	1
Minnesota	20	British Columbia, Canada	1
Mississippi	5	Ontario, Canada	10
Missouri	46	Quebec, Canada	5
Montana	1	England	4
Nebraska	4	Japan	1
New Hampshire	5	Nova Scotia	1
		Total	1215

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MEMBERS DECEASED

Arthur C. Pease	Lowell, Mass	Jan. 3, 1907
James B. Cahoon	New York, N. Y	Feb. 16, 1907
James R. Bowen	Schuylkill, Pa	Mar. 19, 1907
John O. Johnston	Columbus, Ohio	Apr. 21, 1907
Thomas B. Riter	Pittsburg, Pa	Apr. 23, 1907
John S. Wilbraham	Philadelphia, Pa	July 2, 1907
Augustine S. Mallory	New York, N. Y	Aug. 9, 1907

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